beAWARE

Enhancing decision support and management services in extreme weather climate events

700475

D1.4

Public Final Activity Report

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Abstract

In this document, the public version of the work performed during the beAWARE project is reported. The report contains: (i) the presentation of the Consortium, (ii) the presentation of the objectives of beAWARE; (iii) a summary of the results of the Project; and finally (iv) the impact achieved by the Project.

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Executive Summary

beAWARE is a 3-year integrated project being co-financed by the European Commission's H2020 Research Framework Programme. It started on 1st January 2017 and ended on 31th December 2019. The main objective of beAWARE was to develop a platform to support all the phases in a crisis management sequence. This platform collects heterogeneous data from several sources such as weather data, social media, input from drones, and sensors but most importantly it involves people / first responders and citizens who become active subjects in the process by sending visual reports, audio and text messages via a dedicated mobile application. The collected data is analysed and critical information is extracted and synthesized, to provide decision support services to the crisis management authority.

In this document, the work performed during the beAWARE project is reported. The project overall development approach was iterative and organised in three main cycles, each one involving integration, prototype building and evaluation phases. In this context, the work focused on the following innovative objectives: 1) Research study on the requirements for emergency services, 2) multilingual speech and written content extraction, 3) aggregation of multimodal information from sensors, social media, meteorological data etc. 4) visual context analysis, 5) semantic integration for reasoning and decision support, 6) multilingual generation of reports for summarization, 7) research and development of a Main Safety Answering Point (PSAP). Much effort has been spent in developing innovative technologies, as well as in integrating them into the beAWARE System. During the three years of the project's lifetime, several tools and applications were developed, to support the above objectives and to address the three use cases considered in beAWARE (see Table 1). In total, 3 prototypes have been implemented, demonstrated through three large scale pilots and thoroughly evaluated during the three development cycles of the project.

Table 1. beAWARE System's functionalities

#	beAWARE System tools and functionalities	Relative WPs	Relevant Objective
1.	List of Requirements	WP2	Objective 1
2.	Multilingual Text Analysis Module	WP3	Objective 2
3.	Automatic Speech Recognition Module	WP3	Objective 2
4.	Crisis Classification: Early Warnings & Real Time Monitoring	WP3	Objective 3
5.	FROST-Server, geoServer	WP4	Objective 3
6.	Drones Platform	WP3	Objective 3
7.	Social Media Analysis Module	WP4	Objective 3
8.	Visual analysis module	WP3	Objective 4
9.	Knowledge base	WP4	Objective 5
10.	KB Service for Semantic Integration & Reasoning	WP4	Objective 5
11.	Multilingual Report Generator Module	WP5	Objective 6
12.	Main Public Safety Answering Point	WP6	Objective 7
13.	Mobile Application	WP7	Objective 7
14.	UIs for KB, Drones Dashboard, Analysis Workbench	WP3, WP4	Objective 3, 5, 7

There has also been a successful dissemination aspect of the project's results, with the organisation of several events. The consortium has published 43 papers in conferences and workshops giving an overall boost to science in the field of Crisis Management. A focused Network of Interested (NoI) was established to support the direct liaison with relevant stakeholders and to engage them in the project activities that reached 149 members. In the exploitation level, beAWARE has demonstrated its achievements by participating in scientific and industrial exhibitions, workshop and events Finally, a joint exploitation plan has been formed in order to support further promotion and exploitation of the system and a permanent demo environment will be established after the completion of the project to demonstrate the use of the system to potentially interested parties.

Overall, the project has built on its strong scientific outcomes and has successfully resulted to a system able to provide services structured around the disaster management cycle of prevention, preparedness and response with main focus on the three use cases defined to encapsulate the operational scenarios of the project.

Abbreviations and Acronyms

AEMET	Spanish Meteorological Agency
API	Application programming interface
ASR	Automatic Speech Recognition
C2	Command & Control
CDR	Central Data Repository
CI	Continuous Integration
CMU	Carnegie Mellon University : is referred to CMU Sphinx
CRCL	Crisis Classification
DoA	Description of Action
DoA	Description of Actions
DoW	Description of Work
DSS	Decision Support System
DSyntS	Deep-Syntactic Structure
EFAS	European Flood Awareness System
EFFIS	European Forest Fire Information System
EL	Entity Linking
EPS	Ensemble Prediction System
FORGe	Fabra Open-source Rule-based Generator
FROST	FRaunhofer Opensource SensorThings-Server
GIS	Geographical Information System
IDE	integrated development environment
IO	Innovative objectives
IOT	Internet of Things
JRC	Joint Research Centre
JSON	JavaScript Object Notation
K8s	Kubernetes
KB	Knowledge Base
KBS	Knowledge Base System
KPI	Key Performance Indicator
LG	Language Generation
M2M	Machine to machine

MAP	Mean Average Precision
MRG	Multilingual Report Generator
MTA	Multilingual Text Analyser
MTT	Meaning-Text Theory
NE	Named Entity
NER	Named Entity Recognition
NGO	Non-governmental organization
NLG	Natural Language Generation
NLP	Natural Language Processing
NoI	Network of interest
OWL	Web Ontology Language
PCA	Principal Component Analysis
PoS	Part of Speech
PredArg	Predicate-Argument
PSAP	Public-safety answering point
RDF	Resource Description FrameWork
REST	Representation State Transfer
SemS	Semantic Structure
SMA	Social Media Analysis
SMC	Social Media Component
SME	Small and medium-sized enterprises
SPARQL	RDF query language
SRL	Semantic Role Labelling
SSyntS	Surface-Syntactic Structure
SW	Semantic Web
UAV	Unmanned Aerial Vehicles
UC	Use Case
UDs	Universal Dependencies
UHF	Ultra High Frequency
UI	User Interface
UR	User Requirement
VHF	Very High Frequency

VRS	Visual River Sensing
WP	Work Package

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1 beAWARE Consortium

beAWARE comprises a highly experienced and well-distributed consortium of research institutes, industries and First-Responder's organizations. beAWARE's consortium includes ten partners, four of which are research institutes (CERTH, UPF, IOSB, FMI), two big industries (MSIL Israel and IBM Israel) and four are FR teams. Partners are distributed in 7 countries (Greece, Spain, Italy, Germany, Israel, Denmark and Finland). All partners have a wide experience in the domain of security through their participation in numerous European and National projects in the field, which guaranteed the high quality of developed services and the overall project. Most of the partners had also, to a greater or lesser extent, collaborated in several projects in the past, which guaranteed the successful coordination and management of all the project activities. In the following subsections, a thorough description is given of each organization participating in beAWARE's consortium, along with details of their expertise, experience, infrastructure and equipment.

1.1 Centre for Research and Technology Hellas (CERTH)

The Centre for Research and Technology-Hellas (CERTH), founded in 2000, is the only research centre in Northern Greece and one of the largest in the country. CERTH has important scientific and technological achievements in many areas including: Energy, Environment, Industry, Mechatronics, Information & Communication, Transportation & Sustainable Mobility, Health, Agro-biotechnology, Smart farming, Safety & Security, as well as several cross-disciplinary scientific areas. Today CERTH consists of the following five institutes: (a) Chemical Process & Energy Resources Institute (CPERI), (b) Information Technologies Institute (ITI), (c) Hellenic Institute of Transport (HIT), (d) Institute of Applied Biosciences (INAB), and (e) Institute of Bio- Economy and Agri-Technology (iBO).

CERTH is essentially a self-supported Research Centre generating an average annual turnover of ~25M€ coming from: (a) >30% from bilateral industrial research contracts, (b) >60% from competitive research projects, (c) <10% as government institutional funding. More than 700 people work at CERTH with the majority being scientists. CERTH has received numerous awards and distinctions such as the European Descartes Prize, the European Research Council (ERC) Advanced Grant, Microsoft International Contest Prize, the Trading Agents Competition Award and many more. In addition, CERTH is listed among the Top-12 of the EU's Research Institutions with the highest participation in H2020 competitive research grants and is currently among the leading organisations in Greece in securing H2020 funding. CERTH has participated successfully in more than 1200 competitive research projects (with a total budget exceeding 450M€ and involving more than 1100 international partner organizations) financed by the EU, leading industries from USA, Japan and Europe, and the Greek Government via the General Secretariat of Research and Technology (GSRT). CERTH's research results (more than 350 publications per year) have significant scientific impact (about 7100 heterocitations/year). Four spin off companies have been already launched through CERTH's research activities.

Information Technologies Institute (ITI)

CERTH participates in beAWARE through one of its institutes, the Information Technologies Institute (ITI). ITI was founded in 1998 as a non-profit organisation under the auspices of the GSRT, with its head office located in Thessaloniki, Greece. Since 2000 it has been a founding member of the GSRT-supervised CERTH. CERTH-ITI is also an active member of the European Cyber Security Organisation (ECSO), i.e., the contractual counterpart to the European Commission for the implementation of the Cyber Security contractual Public-Private Partnership (cPPP).

The participating team of CERTH-ITI in beAWARE is the Multimedia Knowledge and Social Data Analytics laboratory (MKLab). The MKLab has significant experience and scientific expertise on the technical aspects of beAWARE including (but not limited to) Web discovery and mining, social media monitoring, semantic integration of heterogeneous resources, social network analysis, visual analytics, and multimedia processing, analysis, and understanding. Furthermore, MKLab has a strong background in Semantic Technologies and Knowledge Representation & Reasoning, Artificial Intelligence (including Machine Learning and Deep Learning), Cyber-Threat Information Gathering, Sharing, Intelligence, and Visualisation, Big Data Analytics, Security and Crisis Management.

The team has also relevant expertise in the areas of security in general and cybersecurity. The team has acquired relevant expertise in the security domain through coordinating H2020 SEC-DRS IA **aqua3S** and H2020 SEC-BES IA **ROBORDER** "Autonomous swarm of heterogeneous robots for border surveillance", scientifically managing H2020 SEC-FCT RIA **CONNEXIONs** "Interconnected next-generation immersive IOT platform of crime and terrorism detection, prediction, investigation, and prevention services", and its leading roles in H2020 SEC-DRS IA **INGENIOUS**, H2020 SEC-BES RIA **ARESIBO** "Augmented Reality Enriched Situation awareness for Border security", H2020 SEC-FCT RIA **PROPHETS** "Preventing Radicalisation Online through the Proliferation of Harmonised toolkits", H2020 SEC-FCT IA **TENSOR** "Retrieval and analysis of heterogeneous online content for terrorist activity recognition", and FP7 SEC CP-FP **HOMER** "Homemade explosives (HMEs) and recipes characterisation", as well as its participation to the EDA-funded project **MEDUSA** dealing with multisensor data fusion with application in the situational awareness in urban warfare operations. MKlab has also participated to the surveillance tasks of TRECVID for many years and has established internal collaborations with the Hellenic Police (http://mklab.iti.gr/content/press-article-cooperation-iti-certh-hellenic-policeforensic-sciences-subdivision-northern-gr), the Belgian Federal Police, and Mossos d' Esquadra. The team has also acquired relevant experience in the cybersecurity domain through its leading role in H2020 SU-ICT RIA **ECHO** "European network of Cybersecurity centres and competence Hub for innovation and Operations", one of the four pilot projects towards "establishing and operating a pilot for a European Cybersecurity Competence Network and developing a common European Cybersecurity Research & Innovation Roadmap", and also through its participation in H2020 DS **FORESIGHT** IA "Advanced cyber-security simulation platform for preparedness training in Aviation, Naval and Power-grid environments".

Moreover, MKLab coordinates H2020 CO-CREATION **CUTLER**, H2020 ICT RIA **MindSpaces**, H2020 INSO RIA **MOVING** and H2020 ICT RIA **V4Design**. In addition MKLab is the technical manager in H2020DT-MIGRATION **MiiCT** and H2020 EO RIA **EOPEN** and has leading roles in H2020 SU-ICT RIA **ECHO**, H2020 JTI-IMI2 RIA **RADAR-AD**, H2020 IOT IA **ACTIVAGE**, H2020 ICT RIA **FuturePulse**, H2020 ICT RIA **ReTV**, H2020 ICT RIA **SODALITE**, H2020 ICT RIA **SUITCEYES**. MKLab also participates in the COST Action **MultiForesee** and the Erasmus+ Knowledge Alliances **colMOOC**. MKLab has also successfully coordinated the H2020 ICT RIA **ChainReact**, H2020 ICT IA **Envisage**, H2020 ICT IA **InVID**, H2020 ICT RIA **MAMEM**, FP7 ICT STREP **MULTISENSOR**, FP7 ICT IP **Dem@Care**, FP7 ICT IP **WeKnowIt**, and FP7 ICT IP **SocialSensor**, and has participated in H2020 ICT RIA **DigiArt**, H2020 IA **EMMA**, H2020 ICT RIA **hackAIR**, H2020 ICT **PROFIT**, H2020 ICT **STEP**, H2020 ICT **KRISTINA**, FP7 ICT **Live+Gov**, FP7 ICT **REVEAL**, FP7-ICT **i-Treasures**, FP7 ICT STREP **WikiRate**, FP7 ICT IP **LinkedTV**, FP7 ICT **ForgetIT**, FP7 ICT **PERICLES**, FCT ICT **USEMP**, and FP7 ICT STREP **PESCaDO**. The team also exploits the results of European projects through its spin-off companies Infalia (www.infalia.com) and Carealia (www.carealia.gr).

Finally, through its participation in the aforementioned projects, MKLab has built an infrastructure of considerable computational capacity (400+ cores, 600+GB RAM, 100+TB storage) and has developed a sophisticated distributed architecture for data collection and indexing, as well as a variety of cutting-edge data mining and retrieval algorithms. The team is therefore in excellent position to support a wide range of data collection, mining and indexing needs within research and innovation projects.

Role: The Information Technologies Institute (ITI) of CERTH is the coordinator of beAWARE and is responsible for the management and administrative activities of the project (WP1). ITI-CERTH is also involved in R&D activities related to social media analytics, crisis classification, visual analysis, speech recognition, semantic representation and reasoning for decision support.

1.2 Motorola Solutions Israel Ltd (MSIL)

MOTOROLA SOLUTIONS

Motorola Israel Ltd. was established in 1948, and since 1964 has been a wholly owned subsidiary of Motorola Inc., a multinational communications corporation headquartered in the USA. In January 2011, Motorola Inc. was divided into two separate companies: Motorola Solutions and Motorola Mobility. Motorola Solutions Israel Ltd. (MSIL) was Motorola Solutions Inc.'s first subsidiary outside the USA, and the first design and development centre outside the US.

Motorola Solutions creates innovative, mission-critical communication solutions and services that connects people through technology and help more than 100,000 public safety and commercial customers in more than 100 countries build safer cities and thriving communities. MSIL's solutions span across a variety of industries including law enforcement, fire, emergency medical services, national government security, utilities, mining, energy, manufacturing,

health care, retail, transportation, logistics, education, and public services. The company develops and provides communication solutions based on advanced technologies to governmental bodies, public safety authorities, Enterprises and to a variety of commercial entities in Israel and around the world. MSIL is one of the leading high-tech companies in Israel. It comprises several business units involved in the company's R&D, marketing and sales activities, and solutions and integration services functions. The Design Center is an industry leader in implementing prestigious global projects such as developing broadband (LTE) products for emergency, public safety and security organizations and mobile terminals for the global courier industry and commercial enterprises. These include technology and market leading TETRA and ASTRO systems - the foundation for security forces' communication networks; ruggedized mobile computing terminals; Safe City and command and control solutions; power-,water- and irrigation control and monitoring systems; advanced GPS integrated location systems; and enterprise wireless access networks that also deliver high quality service on trains around the world. The Advanced Services group is responsible for planning and implementing solutions and systems for all customers in Israel and in the export markets and for providing support, maintenance and added value services to all the customers. The Advanced Services group employs highly qualified engineers specializing in analysis, planning and design, provision of solutions, integration and management of projects involving complex communication systems and products for the institutional market and for public safety bodies. The group develops and deploys Safe City Solutions in Israel and abroad. These solutions include full command and control application and service suites, wireless access networks, mobile video, analytics, GIS, incident management, public announcement, emergency buttons, and more.

MSIL has an extensive experience in EU projects with significant experience in multidisciplinary systems, architectural design, development mediation, interface specifications, IT and device management in enterprise and public safety systems, customer care applications development, integration and testing. MSIL has held multiple roles of coordination, technological management and WP leadership in FP5-FP7 and H2020 programs (i.e. H2020 CREST, H2020 CONNEXIONs) and in national R&D programs as well. MSIL has vast experience in leading highly advanced technological projects which include the design, development, integration and implementation of End-to End solutions.

MSIL brings in beAWARE its experience in multidisciplinary systems architectural design, interface specifications, embedded hardware and software, IT and device management development of enterprise and public safety systems, customer care applications, integration and testing.

Role: In beAWARE, MSIL was responsible for implementing the main Public Safety Answering Point for handling "calls" enriched with multimedia content (WP6) and carried out tasks of developing the user interface and visualization, data integration. Finally, MSIL contributed to the communication network implementation and integration tasks (WP8).

1.3 Universitat Pompeu Fabra (UPF)

Universitat Pompeu Fabra (UPF) was established in 1990 as a public university with a strong dedication to excellence in research and teaching. In the meantime, it has become the 1st Spanish university in the world Top 200 (THE2018) and among the best 15 under 50 years (THE2018). According to the U-Ranking 2018-2019 of the BBVA Foundation & Ivie, UPF is also ranked first among Spanish universities for the 7th consecutive year. It was the 1st Spanish University to obtain the "HR Excellence in Research" distinction in April 2014. In beAWARE, UPF participates through the Natural Language Processing Group (UPF-TALN) of the largely international (60% of its staff come from 48 countries other than Spain) Department of Information and Communication Technologies (DTIC) and the Business Shuttle of the UPF. DTIC is strategically located within the vibrant 22@ technological district of Barcelona. It has an important track record of active participation and in EU projects, including coordination (a total of 66 FP7 projects and 10 other projects in non-FP7 program such as CIP, Ambient Assisted Living and the Lifelong Learning Program, and, up to now 38 H2020 projects). DTIC is the Spanish university department with the largest number of ERC grants (9 FP7 and 9 H2020), and is part of the FET Flagship initiative "The Human Brain Project". It is the only Spanish ICT department that has been awarded the "María de Maeztu" excellence by the Spanish government for the quality and relevance of its pioneering scientific research, and as the top IT research concentration in Spain.

UPF-TALN (http://www.taln.upf.edu/) has been founded in 2005 by its current director Prof. Leo Wanner. During the 15 years of its existence TALN has gained widely acknowledged expertise in a number of areas in Natural Language Processing, including text analysis, content (concept and concept relation) extraction from multilingual material, multilingual text generation and summarization, natural language interaction and speech processing. UPF-TALN has a solid record of coordination of and participation in large scale European and national RTD projects – among them **MARQUIS** (EDC-11258), **PATExpert** (FP6-ICT-028116), **PESCaDO** (FP7-ICT-249584), **TOPAS** (FP7-SME-286639), **MULTISENSOR** (FP7-ICT-610411), **Dr. Inventor** (FP7-ICT-611383), **iPATDoc** (FP7-SME-606163), **KRISTINA** (H2020–645012–RIA), **TENSOR** (H2020-700024-IA), **Able to Include** (CIP-ICT-PSP-2013-7/621055), **V4Design** (H2020-779962-RIA), **CONNEXIONs** (H2020-786731-RIA), **MindSpaces** (H2020-825079-STARTS) and **INGENIOUS** (H2020-833435-RIA).

DTIC houses significant infrastructure for both IT work (computing, specialized audiovisual equipment) and experimentation with human subjects (experimental rooms with specialized equipment). Transversal to all DTIC research groups are the computational capabilities provided by a joint cluster, composed of 11 computing machines, 1 single head node and 5Tb of NFS shared space. DTIC is committed to foster the free access to scientific knowledge. The scientific results are being disseminated via the UPF OpenAIRE compliant repository (http://repositori.upf.edu/) or other specialised repositories such as arXiv.

Role: In beAWARE, UPF was responsible for a number of R&D tasks related to multilingual text analysis and report generation.

1.4 Fraunhofer Institute of Optronics, System, Technologies and Image Exploitation (IOSB)

The Fraunhofer-Gesellschaft is a leading organization of institutes of applied research in Germany, undertaking contract research on behalf of industry, the service sector and the government. Fraunhofer-Gesellschaft is actively involved in industrial consortia seeking technical solutions to improve the competitiveness of European industry. At present, the organization maintains 72 research institutes with some 26,600 employees at locations throughout Germany.

In December 2017, the Fraunhofer-Gesellschaft was awarded the Logo «HR Excellence in Research» from the European Commission in recognition of its outstanding Integrated Human Resources Management. The Logo «HR Excellence in Research» is based on the 40 principles of the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers («EU-Charta & Code»). As Europe's leading organization for applied research and as a project partner in many EU-projects, Fraunhofer fulfills these principles. Fraunhofer is one of the first organizations for applied research in Germany to receive the Logo.

The Fraunhofer Institute of Optronics, System Technologies and Image Exploitation (IOSB), that participates in beAWARE, has 530 permanent employees, of which 350 are scientists or engineers, and has annual operational costs of about 57 million € (2018). IOSB develops innovative concepts and application solutions in information technology. It provides sustainable solutions of advanced control and information management, monitoring and diagnosis systems mainly for industrial partners including SMEs as well as for public bodies such as environmental agencies. IOSB has over 30 years of experience in the design, implementation, integration and optimization of complex control and information management systems for distributed applications using modern model and knowledge-based methods. Advanced techniques for information fusion and handling of big data are used in monitoring and control applications in environmental and industrial domains. Activities are structured in 5 business units: 1) Automation and Digitalization, 2) Energy, Environmental and Security Systems, 3) Inspection and Optronic Systems, 4) Artificial Intelligence and Autonomous Systems and 5) Defense. IOSB is an associated member of the Center for Disaster Management and Risk Reduction Technology (CEDIM). IOSB has participated in many FP7 and H2020 projects with leading roles in the environmental and early warning domains. Some of the projects, in the field of security, that IOSB has participated are: the FP7 - SEC-2012-1 – **SAFEWATER** "Innovative tools for the detection and mitigation of CBRN related contamination events of drinking water", the FP7 - ICT-2009.4.3 **TRIDEC** "Collaborative, Complex and Critical Decision-Support in Evolving Crises", the H2020-DRS11-3-2015 - **HERACLES** – "HEritage

Resilience Against CLimate Events on Sites", the H2020-ICT-2015 – **symbIoTe** – "Symbiosis of smart objects across IoT environments".

Role: In beAWARE, IOSB was responsible for a number of R&D tasks related to aggregation and semantic integration of emergency information for decision support and early warnings generation, including the creation of the beAWARE ontology, the development of the SensorThings API and the mobile application.

1.5 Valencia Local Police (PLV)

PLV is a Law enforcement agency in the city of Valencia. The city of Valencia has a metropolitan area which reaches over 1,500,000 inhabitants. It is, in terms of population, the 3rd largest city in Spain. Around 1600 police officers form the Valencia Local Police. The duties of the Valencia Local Police (PLV) are wide, ranging from surveillance of crowded events, aerial surveillance & monitoring with UAV/drones, road traffic control, management of emergencies, environmental police, investigation traffic accidents, citizen security, community police, domestic violence, mediation police, etc. Community policing together with foot patrolling, which is a strategic approach that has been implemented for more than 30 years, is one of the PLV´s operational strengths in terms of information gathering to fight against violent radicalisation. Furthermore, our commitment in fighting against Hate Crimes brings PLV the opportunity of being in touch with all diverse communities in Valencia. Consequently, we work on early detection in radicalisation matters.

Overall PLV is one of the most active local police forces in Spain due to their continuous innovation in technology. Its Centre of Security and Emergencies is the best example of innovation in police management by using ICTs tools, as well as a great test bed for pilot experiences and tests. PLV has managed (as leader or partner) 23 successful European projects form different Programs (H2020 – Secure Societies, 7th FP of R+D in Security, Lifelong Learning Program, Prevention and Fight against Crime, Daphne III, Civil Protection Financial Instrument, Criminal Justice, etc) during more than 13 years (since the EU projects department was created). Some of the security projects that PLV has participated include: the FCT-16-2015 **TAKEDOWN**: Ethical/Societal Dimension Topic 4 - Investigating the role of social, psychological and economic aspects of the processes that lead to organized crime (including cyber related offenses), and terrorist networks and their impact on social cohesion, the FCT-15-2015 **MEDIA4SEC**: Ethical/Societal Dimension Topic 3: Better understanding the role of new social media networks and their use for public security purposes, the FCT-14-2014 **INSPEC2T**: Ethical/Societal Dimension Topic 2: Enhancing cooperation between law enforcement agencies and citizens - Community policing, the **ROCSAFE**: Remotely Operated CBRNe Scene Assessment & Forensic Examination. The overall goal of ROCSAFE is to fundamentally change how CBRNe events are assessed, in order to and ensure the safety of crime scene investigators by reducing the need for them to enter high-risk scenes when they have to determine the nature of threats and gather forensics, the **FORENSOR**: is a Research & Innovation project – an Innovation Action – co-funded by the Horizon 2020 Framework Programme of the

European Union, consisting in the development of an intelligent, autonomous, miniaturised sensor for evidence gathering, the **CARISMAND**: Culture and Risk management and natural disasters.

Among other equipment, PLV owns a specialized police management platform, namely an Intelligent System for Emergencies Response. PLV also owns a WEBPOL e-learning campus for European police officers, which is the training system used by PLV. PLV also has all the adequate facilities to implement field studies, pilot tests and many other tasks. PLV has one of the most advanced emergency management centers. The emergency management center in the Valencia Local Police is called CISE. It is the hub of the local police in València, being operational 24 hours a day. It coordinates services for all units of Valencia Local Police. It is also responsible for maintaining the operational link with other law enforcement agencies, health emergencies, civil protection, lighting, municipal services, etc. It also works in extraordinary events such as Las Fallas, the World Championship, Formula 1 races, the America's Cup, Easter parades, fairs, lots of different sports events and all the major events of global impact which take place in the city of Valencia. It receives a large number of calls per day (290,000). Additionally, The Valencia Local Police has a great experience in pilot testing. Finally, it should be noted that the Valencia Local Police has a specific unit for drones.

Video: https://www.youtube.com/watch?v=YYMK8RmRUHw

Role: In beAWARE PLV was involved in shaping the user requirements in WP2 and in validation of the developed platform through their participation in the Pilots and especially the organisation of the Fire Pilot. Moreover, PLV will host the permanent demo environment to demonstrate all the platform capacities and to generate interest to third parties for the platform.

1.6 Hellenic Rescue Team (HRT)

Hellenic Rescue Team (HRT) is a volunteer non-profit Search and Rescue (SAR) organisation, with a human potential of 2.000 volunteers all over Greece and Headquarters in Thessaloniki. HRT participates in SAR missions in cases of urgent needs and massive disasters, either in Greece or abroad. It is acknowledged by Civil Protection Authorities in Greece and EU and a member of the United Nation - International Search and Rescue Advisory Group (UN-INSARAG), and the only Greek member in the International Maritime Rescue Federation (IMRF) and the Internationale Kommission fur Alpines Rettungswesen/Commission Internationale de Sauvatage Alpin (IKAR/CISA). HRT's main mission is the search and rescue of people in need and the organisation of Aid Missions in natural and manmade disasters all over the world, nevertheless a major objective (and vital tool to achieve our mission) is Research and Development in the area of Search and Rescue, crisis and crowd management, telecommunications, ICT for first responders.

Within the Hellenic Rescue Team area, there are seven specialised departments, namely:

USAR - Massive Disasters: HRT has at its disposal a team in a state of alertness, fully

technologically equipped. HRT's corporate planning is to intervene in any part of the world, in case of earthquakes, floods and extended catastrophes as Turkey and Athens (99), Morocco and Algeria (03), Pakistan (04), Haiti (2010).

Mountain Rescue: the richest in experience HRT Department, having participated in over 100 missions of Search and Rescue also has all the appropriate apparatus and the perfect training to intervene in mountain accidents and air crashes, accomplishing even the most difficult operations.

Water Search and Rescue: its members are experienced scuba divers, speed-craft controllers, sailors, bay-watchers and support crew who are participating in Search and Rescue (SAR) at sea, rivers, and lakes. They are in constant cooperation with the Hellenic Coast Guard and the Hellenic Air Force. Most recently, HRT through its Water Rescue Department (WRD) was very active in the refugee crisis in the Eastern Aegean saving numerous lives. Furthermore, through its partners in IMRF, HRT has increased substantially its ability in sea rescue through specialised training.

First Aid: professionals in health domain support the rescue departments of HRT providing first aid during our missions. In addition, they train new HRT's members in First Aid.

Research, Technology and Telecommunications: the development of the specialised knowledge of HRT's members led to the exploitation of modern technology and its focusing on creating applications and devices useful in Search and Rescue. The Department has a portfolio of a variety of pioneer inventions.

Humanitarian Missions: this department collects, carries over and distributes humanitarian aid to populations suffering from disasters and abnormal crisis. In addition, in cooperation with the Greek Government as well as the European Union (ECHO), HRT is in charge of the management of aid programs towards third countries. In the past, some of these countries have been: Afghanistan (1999), Iraq and Iran (2004), Indonesia and Sumatra (2005), Lebanon (2006), Gaza (2009), Haiti and Chile (2010).

Training: HRT organises special schools and seminars by professional trainers, in Greece and abroad, in order to provide its members with all the technical knowledge that is required.

HRT is an experienced Search and Rescue organisation with a record of numerous Search and Rescue operations in various fields and many events, relevant to beAWARE's main scenarios. Moreover, during the past five years HRT participated in various research projects with similar roles (definition of requirements, field testing and dissemination). HRT has also experience in R&D activities, through its participation in several projects, such as: the FP7 SEC **CONCORDE** "Development of Coordination Mechanisms During Different Kinds of Emergencies", the FP7 SME **RESCUECELL** "Portable Kit For Detecting Trapped And Buried People In Ruins And Avalanches", the FP7 SEC **COSMIC** "The COntribution of Social Media In Crisis management", the INTERREG IPA CBC **HELP** "Integrated Operations Center for Providing Humanitarian Assistance.

HRT has also significant equipment for supporting field pilots, such as: a van which serves as a mobile operations centre called "Hermes", which carries all necessary equipment for managing a crisis, such as a communication centre, internet connection, satellite

communication, etc.; 19 rescue vessels for sea rescue; 2 rescue runners; 2 snow vehicles; suitable suits for ground personnel, who are involved in fire response; various first-aid and SAR equipment; nationwide communication network; 2 mobile Wi-Fi communication antennas.

Role: In beAWARE, HRT was involved in shaping the user requirements in WP2 and in evaluation of the developed platform through their participation in the Pilots and especially the organization of the Heatwave Pilot. Moreover, HRT led the exploitation and dissemination activities (WP8) of the project.

1.7 Finnish Meteorological Institute (FMI)

FINNISH METEOROLOGICAL INSTITUTE

Finnish Meteorological Institute (FMI) is mandated by the Finnish government to produce reliable information on the state of the atmosphere, and its characteristics and phenomena, with the aim of promoting safety and serving various needs of the public, industry and commerce, as well as contributing to scientific ends. FMI observes the physical state, chemical composition and electromagnetic phenomena of the atmosphere and seas, as well as the physical state of the Baltic Sea and the Arctic marine region. Operating on the 24/7 principle, the Institute produces information and services about the past, present and future states of the atmosphere and seas.

FMI employs about 720 people, about 50% of which are involved in research. The Finnish government has designated FMI as the national air quality expert; FMI is also responsible for the national background air quality monitoring. Most of our measurements are part of the international monitoring and research programmes. Atmospheric dispersion models have been developed and applied at the Finnish Meteorological Institute since the early 1970's, addressing the following main topics: urban air quality and exposure, regional and long-range transport and accidents involving hazardous and radioactive materials. FMI also conducts research of a high international standard in the fields of meteorology, marine sciences, air quality, space physics and earth observation. The FMI carries out competitive business specialised in expert services, both in Finland and abroad, and contributes actively to national and international cooperation in its field. It also works to keep decision-makers, industry and the general public constantly informed of issues associated with the atmosphere, seas and near space. FMI's projects of Atmospheric Composition Unit involve monitoring of air quality and atmospheric composition (e.g., EMEP, HELCOM/EGAP, WMO/GAW, AMAP), research and development in air chemistry and aerosol physics (including a National and two Nordic Centres of Excellence), and assessment and modelling of airborne pollutants (including also pollen, volcanic ash, smoke from forest fires) from the local to the continental scale. Relevant FMI's activities involve: measurements and modelling of atmospheric environment, big data processing (meteorological and environmental data from satellites and in-situ measurements), data fusion.

FMI had a also active role in several security projects, such as: FP7 ICT **PESCaDO** "Personalized Environmental Service Configuration and Delivery Orchestration", H2020 BG **INTAROS** "Integrated Arctic observation system", Copernicus Atmosphere Monitoring Service (CAMS-

50). FMI group has a very strong expertise also in various other recent and ongoing European Research projects including: EU/FUMAPEX, EU/OSCAR, EU/GEMS, EU/PROMOTE, EU/CAIR4HEALTH, EU/MARQUIS, EU/HENVINET, EU/HIALINE, EU/MEGAPOLI, EU/PEGASOS EU/TRANSPHORM, EU/BSR InnoShip, ESA/Samba, ESA/Atila, ESA/SMASH, EU/Interreg/SNOOP, EU/PASODOBLE , EU/GMES User Uptake, EU/ PBL-PMES, ESA/VAST, , ESA/GlobalEmission, EU/MarcoPolo, EU/MACC I,II and III.

FMI has also significant infrastructure and equipment, which includes a measuring network over 400 stations and Cray XC30 supercomputer facilities for operative forecasting and research purposes. FMI makes observations of the atmosphere, sea and space at over 400 stations around Finland using remote sensing instruments such as radars and satellites. In addition to weather observations FMI monitors air quality, radioactivity and properties of the upper atmosphere. FMI has a Cray XC30 supercomputer, which includes two identical units, one of which is used in production and the other one acts as backup. During normal operations, the backup unit is available for research purposes. Both units consist of 3420 computational units with a peak power of 70 TFlops.

Role: In beAWARE, FMI was responsible for the weather forecasting and extreme climate events prediction and also was the WP2 leader.

1.8 IBM Israel - Science And Technology LTD (IBM)

IBM has the world's largest IT research organization, with more than 3,000 scientists and engineers working at 12 labs in 10 countries. IBM invests more than $5 billion a year in R&D and is the world's leader in patent filings. The company holds nearly 37,000 patents worldwide. IBM strives to lead in the creation, development and manufacture of the industry's most advanced information technologies, including computer systems, software, networking systems, storage devices and microelectronics. IBM participates in and contributes heavily to the work of standards consortia, alliances, and formal national and international standards organizations. Where appropriate, IBM adopts consensus technologies to maintain openness, interoperability, and application portability.

IBM Israel Science and Technology Ltd (IBM ISRAEL) for short is known as IBM Research – Haifa. Since it first opened, the IBM ISRAEL research lab has conducted decades of research that have proved vital to IBM ISRAEL's success. The lab is the largest of the research laboratories located outside of the United States and has close working relationships with IBM Israel and its twin research laboratory in Zurich. In Haifa, 25% of the technical staff has doctorate degrees in computer science, electrical engineering, mathematics, or related fields. Employees are actively involved in teaching in Israeli higher education institutions and in supervising post-graduate theses. R&D projects are being executed today in areas such as storage systems, cloud computing, mobile, healthcare and life sciences, verification technologies, business transformation, information retrieval, programming environments, optimization technologies, and analytics.

The Cloud and IoT Foundations department is involved in developing software technologies to exploit advances in computing infrastructure that benefit IT users from traditional enterprise IT, system engineering, IoT and cloud based IT developers and consumers. The department's technology areas span distributed middleware, cloud computing technologies and business models, mobile and client platform middleware, event-based and proactive middleware, location-based descriptive, predictive and prescriptive analytics. The group focuses on scalable and highly available infrastructure for IBM middleware, such as extreme transaction, high throughput messaging technologies. In addition, the technologies developed enhance dependability in very large-scale multi-tier environments and support hosting web applications and services in large-scale compute clouds. The group is also heavily involved in research and development projects in IoT, edge and blockchain related technologies.

Since FP4, IBM ISRAEL has participated and led numerous EU-funded projects and is considered an Israeli leader in FP participation. Eight projects have been coordinated by IBM ISRAEL: CloudWave, COMPOSE, ENSURE, RESERVOIR and VISION Cloud (FP7 IP projects), +Spaces, ACSI and PINCETTE (FP7 STREPs). In addition, IBM ISRAEL is an important contributor in many consortiums, including FI-PPP projects such as FI-WARE, FI-SPACE, and FInest. It has also participated in FP7 **COMPOSE**, which had a goal of enabling new services that can seamlessly integrate real and virtual worlds through the convergence of the Internet of Services with the Internet of Things; the FP7 **FIspace**, which developed a multi-domain Business Collaboration Space employing FI technologies for enabling seamless collaboration in open, cross-organizational business networks; FP7 **PANACEA**, with main objective to provide Proactive Autonomous Management of Cloud Resources as a remedy to the exponentially growing complexity; H2020 **NIMBLE**, which developed infrastructure for a cloud-based, Industrie 4.0, Internet-of-things enabled B2B platform on which European manufacturing firms can register, publish machine-readable catalogues for products and services, search for suitable supply chain partners, negotiate contracts and supply logistics, and develop private and secure B2B and M2M information exchange channels to optimise business work flows. More information about our currently running projects is available at https://www.research.ibm.com/haifa/EUProjects.shtml.

Finally, regarding equipment IBM contributes several drones of different types used during development and during local testing of the capabilities introduced.

Role: In beAWARE, IBM was leading the development of the architecture and the infrastructure of the platform and was involved in R&D activities related to the usage of drones in the project.

1.9 Alto Adriatico Water Authority (AAWA)

Autorità di Bacino
DEI FIUMI ISONZO, TAGLIAMENTO, LIVENZA, PIAVE, BRENTA-BACCHIGLIONE

The Alto Adriatico Water Authority (AAWA) is a Public Body responsible for the management of the rivers flowing into the Northern Adriatic Sea, namely Isonzo, Tagliamento,

Livenza, Piave, and Brenta. The AAWA is in charge of the catchment planning, including remedial measures to reduce hydraulic and geological risks, as well as for the protection and the sustainable use of water resources. It coordinates the activities to be implemented on a basin scale such as safeguarding the quality and quantity of water resources, attain the best possible balance among the contrasting water use, study the schemes necessary to prevent, in particular, disastrous events - droughts and floods. According to the Water Framework Directive 2000/60/EC and Floods Directive 2007/60/EC, the AAWA coincides with the Eastern Alps river District and promotes Basin Plans which indicate the objectives of water resources and flood risk management in the North East Italy, and the measures aimed to achieve these objectives.

AWAA has a wide experience in European Research projects, some of which are: FP7 - ENV. 2010.1.3.2-1 **KULTURisk** "Knowledge-based approach to develop a cULTUre of Risk prevention", FP7 - ENV - 2013 - Water Inno – Demo **MARSOL** "Demonstrating Managed Aquifer Recharge as a Solution to Water Scarcity and Drought", FP7 ENV.2012-6.5-1 **WeSenseIt** "Citizen Observatory of Water".

Role: In beAWARE, AAWA was responsible as domain expert for the flood use case and requirements and for the organisation of the Flood Pilot. Also, AAWA participated actively in the execution and evaluation of the rest of the Pilots.

1.10 Frederikssund-Halsnæs Fire & Rescue Service (FBBR)

Frederiksborg Fire & Rescue Service provides fire and rescue services to municipalities of Frederikssund, Halsnaes, Hillerød, Gribskov, Egedal and Furesø in the center of the island of Zealand, in Denmark. The six municipalities are home to approximately 250.000 inhabitants, who live within a land area of 1058 square miles.

The fire department's key activities and responsibilities include responding to and preventing; fires, road accidents, flooding, fires at sea, hazardous material and chemical incidents, major incidents including terrorist attacks, boat preparedness and providing other humanitarian services such as rescuing casualties from a variety of emergency scenarios. Like all fire and rescue services in Denmark.

Frederiksborg Fire & Rescue Service's operational activities are overseen at the national level by the Ministry of Defense. Frederiksborg Fire & Rescue Service has long term strategic aims of providing the social, economic and environmental well-being of the residents of the six municipalities. Central to this is a focus on preventing fires and other emergencies from happening and in doing so reducing death, injury and damage to property.

Frederiksborg Fire & Rescue Service has participated in several research projects, such as: DG ECHO **MAppERS** "Mobile Applications for Emergency Response and Support", DG HOME **TETRIS** "Terrorists In Europe Targeting Railway InfrastructureS", Erasmus+ KA2 **e-PPR** "e-

Learning for the Prevention, Preparedness and Response to Natural Disasters", H2020 SEC **HEIMDALL** "Multi-hazard cooperative management tool for data exchange; response planning and scenario building", DG ECHO **CASCADE** "Community Safety Action for Supporting Climate Adaption and Development".

Role: In beAWARE, FBBR was responsible as domain expert for the Fire use case and requirements.

2 Project context and objectives

The overall context of beAWARE lies in the domain of situational awareness and command and control (C2). The first phase concerns the forecast of imminent disasters and the relevant preparations. Once a disaster occurs, an initial assessment needs to be conducted as soon as possible, to determine the scope, geographical distribution, and scale of the incident. Situational awareness means being able to accurately determine what has happened, what is happening now, and what will come next, all in order to plan and coordinate the most effective response possible with the available resources. This observation phase will lead to an orientation phase, including both an individual and collective “cognition” orientation to data that is sensed and communicated. Once orientation to the data (or the lack of it) occurs then a decision is made, ultimately resulting to the final step, the “action” phase.

The crisis management center is always striving or struggling to obtain a situational awareness as complete as possible, in order to feel that they can take a decision that is the "best possible" given the circumstances. Then, a decision is made at the smallest deployable/operational unit or at a higher level of the C2 function. Integral to the “action” phase is the ability to communicate the suggested action and then monitor the action (feedback loop) in order to determine whether it had the expected effects. Getting the right people and resources to the right place at the right time is the essence of the command and control aspect of disaster response.

Obj.1 – Perform a research study on the requirements for emergency services given the current digital landscape (i.e. end user in emergency need, PSAP operator, first responder).

The aim of this objective was to identify the needs for emergency services within the current accessible digital landscape. The research tried to find the gaps in e.g. the present warning technologies and propose improvements with the aim of filling the gaps.

In order to achieve this objective a spiral process (requirements elicitation process) was established throughout the entire project, where every iteration was based on the outcomes of the previous.

To summarize these steps: we have started at the beginning of the project with the definition of the use cases and requirements (D2.1) and the evaluation methodology (D2.2), following a specific and collaborative approach in order to define the user requirements and the use cases of the project. All the user requirements and the use cases emerged from the actual needs of end users. They are addressing problems and issues that they are facing during their everyday practice. All the user requirements, combined with a research study that identified the status of available tools through an existing situation analysis, clarified the current digital landscape concerning emergency service requirements. Additionally, this study identified gaps in the existing digital landscape, identified needs that are not currently met and set the ground for future development. This led to the definition of the technical requirements of the project in order to improve early warning and coordination between first responders and authorities.

Then, the first pilot set-up and its evaluation methodology (D2.3) for testing the first prototype, as well as its evaluation results (D2.4) were delivered. The outcomes of the first cycle of evaluation set the bases for the final definition of the user requirements (D2.10) and addressed the technical implementation of the 2nd prototype and the second pilot set-up (D2.5). The second prototype was tested and evaluated on the occasion of the flood pilot and the results documented in D2.6, which played a key role in the implementation of the final system and the third pilot set-up (D2.7).

During the evaluation of the 2nd prototype (P2), some participants expressed the opinion that the beAWARE technologies should be tested also considering some potential technical issues (i.e. no power, no connectivity etc.) related to the crisis, since in their opinion, the platform relied too much on the internet network which could fail in case of an emergency situation. This was also requested by the reviewers during the second project's review. For that reason, the third pilot considered also the incorporation of stress situations like power outage issue and an internet connection failure. The reproduction of these eventualities ensured the beAWARE's usability and interoperability in situations which are likely to occur during an emergency, proving the usefulness of the platform even in the most challenging environments. Moreover, since one of the main outcomes of the second cycle of evaluation and the second review of the project was that, according to the reviewers' and the end users' opinion, the beAWARE platform should not be considered as a total replacement of the current tools ("legacy" tools), this has been taken into account for the third pilot by the addition of a "blended" session. The blended session of the third pilot managed in fact the emergency by a mixture of the beAWARE platform and the legacy tools, taking the best of each other session and providing an optimal interaction between the beAWARE platform and the current equipment.

Starting from this improved approach for the final setup and evaluation, the final prototype of the beAWARE platform was tested in the Fire pilot in Valencia (14th of November 2019), where the final system was evaluated (D2.8), closing this way the circle of the evaluation of the system.

We would like to emphasize that each one of the above steps was carried out with high involvement of the technical partners, the end users and stakeholders.

Finally, it should be noticed that beAWARE spiral process of implementation – testing – evaluation, which was repeated from the first prototype to the final system, has really led to an improvement of the platform in the direction indicated by the end-users and the stakeholders, as every new step of implementation was effectively based on the results of the previous one. So, the final system, as it was the main expected result from the end-user partners, covers the final list of UC and UR for each scenario.

Obj.2 – Multilingual speech and written communication analysis in emergency calls

The capability to grasp the content of any message transmitted by a citizen in danger during an emergency is very crucial in the context of beAWARE.

To fulfill this objective beAWARE designed and developed the following components:

- *Speech recognition*: In order to automatically extract information from emergency calls and audio messages, an automatic speech recognition (ASR) was developed in the framework of beAWARE's platform. Existing open source language models and acoustic models, for all the languages of the project, were adapted and fine-tuned by using emergency-related recordings and vocabulary in order to enhance emergency-related terminology during speech recognition and enhance accuracy, even in noisy environments or low-quality sound. Existing dictionaries were also cleaned and enriched. The initial version of the component was receiving only recorded audio messages from the beAWARE mobile application. In the second prototype, beAWARE consortium, addressing reviewers' comments, also installed a call-center solution, which was able to record emergency calls, and created the necessary services to transfer the recorded calls to the ASR component. Moreover, in order to showcase the ability of the platform to integrate with existing tools, during the "blending" phase of the 3rd Pilot, the component was adjusted in order to communicate and transcribe calls coming also from PLV's existing call center.
- *Transcribed and written communication analysis:* In order to extract concepts and conceptual relations from textual material (texts, social media postings, and transcribed spoken language) a multimedia text analysis module was developed. beAWARE extended and improved the knowledge extraction techniques to detect from multilingual text a much wider range of incidents and impacted objects, as well as locations and states associated with incidents. The coverage has been improved both on the input side - range of linguistic expressions recognised in text found in audio transcriptions and social media texts- and on the output side -number of ontology concepts and specific entities extracted.

Obj.3 – Aggregate multimodal information from sensor networks, meteorological stations, etc. and social media for decision support and validation purposes and issue early warnings.

beAWARE has designed and developed the procedures and the relevant infrastructures to support the aggregation of multimodal information. beAWARE system collects information from the following sources:

- Meteorological data (forecasting weather data and real-time weather observations)
- Hydrological data (river water level) forecasting and real-time observations from sensors located in the river
- Flood risk maps from AAWA and fire hazard maps from EFFIS
- Video (from the beAWARE mobile application and static cameras)
- Images (from the beAWARE mobile application)
- Audio (from the beAWARE mobile application and the Call Center)
- Social media data relevant to a specific crisis (from Twitter)
- Aerial imaging from drones

beAWARE integrated all the above components in order to retrieve real-time contextual information. The sensing data (forecasts and observations for river water level and weather

parameters) are stored to the SensorThings Server API (FROST). A data acquisition mechanism has been developed to extract the stored data for further analysis. In pre-emergency phase, the forecasts are employed so as to assess the severity level of an upcoming crisis event. During the crisis, the estimation of the severity level of ongoing crisis is based on the real-time observations which are fused with the outcomes of multimedia and textual analysis. In the flood use case, the real-time risk assessment process has been enhanced by the information which extracted from the flood risk maps implying the exposure and vulnerability of the assets and other cultural elements at risk.

The beAWARE platform takes measures against erroneous and malicious data from all sources. A two-layer validation method ensures that the data that are consumed and presented to the end users are correct and accurate. The first layer of validation takes place at the analysis modules and validates individual images, videos and tweets. The second validation layer parses the output of the Knowledge Base Service and correlates it with environmental and weather metrics to detect and eliminate false information presented to end users.

Regarding the individual analysis of each type of collected data, in the context of beAWARE several analysis components were developed. A social media crawler was deployed able to extract emergency-specific information from tweets and able to apply a validation mechanism for identifying and filtering fake, unimportant and irrelevant tweets. ASR and MTA components were developed in order to extract concepts from speech, as mentioned in the previous objective. Finally, several image and video processing algorithms were deployed so as to extract concepts related to flood, fire or heatwave crisis events from visual data captured at or near the impacted site through the mobile application and static cameras. A validation mechanism of visual content will only forward to the aggregation mechanism items that show either an emergency taking place, or targets that are possibly in danger. The latest addition was the drones platform which enabled through its supported autonomous piloting and control of on-board equipment, to provide a real-time feed from the air, thus complementing the previously existing points of view.

Obj.4 – Visual context analysis during emergency calls.

This objective aims at understanding the visual context of a person calling in an emergency or the reporting from a first responder, where the term ‘call’, in a wider sense, refers to the reporting of a person for an emergency situation by using all the available multimedia context that beAWARE mobile application provides.

To enable the above, beAWARE designed and developed the Image and Video analysis components to extract high-level information such as type of the crisis (flood, fire), detect impacted people, animals, cars, indoor/outdoor, city landscape/deserted area by extracting low-level features from visual data and translate them into high-level concepts based on supervised machine learning techniques. The extracted visual concepts lead primarily to real-time detection and assessment of occurring events and their type, as well as a global understanding of the situation in the affected area (people impacted, traffic conditions etc.)

Obj.5 – Semantic integration of multimodal information from the emergency calls, M2M/IoT platforms and social media for decision support and generation of early warnings.

The key direction of this objective is to research and develop technologies for semantic integration of the diverse multimodal content to enable reasoning for decision support in the PSAP, as well as for the generation of early warnings.

To enable the semantic integration beAWARE designed and developed the following tools:

beAWARE Early warning: Designed and developed the crisis classification component that is able to provide estimation of the future crisis level based on meteorological data, sensor data and past data, such as historical meteorogical data, past sensor measurements and past events (that are utilised for the creation of risk maps). Moreover, the social media component is able to identify relevant tweets from the citizens and inform the authority accordingly when there is no other information available. Visual information from static cameras is also leveraged in order to automatically extract visual information regarding the river's condition and create relevant warnings.

beAWARE Decision support: An ontological framework that semantically represents all the extracted information from user input coming from the mobile application (image, video, text, audio messages) and the integrated call center (recorded phone calls), drone footage and social media crawling. Appropriate ontological structures have been created, which provided the backbone of the reasoning mechanisms. beAWARE is now able to estimate the severity level of an incident, to cluster relevant incidents and to inform the authority accordingly. A two-layer validation mechanism, both at the component level and at the Knowledge Base level, was integrated to validate the incoming data and filter conflicting or irrelevant information. The semantic content is linked to available M2M/IoT platforms and integrated together with the risk maps, which is presented to the authorities.

The semantic integration of multimodal data-streams coming from variable complementary sources enables both tools to be able to extract valid information even when some sources contain partial, imperfect or fake information.

Obj.6 - Multilingual report generation from aggregated emergency data.

beAWARE introduced a new type of summary report issued at the end of an emergency scenario and covering the most relevant incidents in chronological order. Methods for mapping ontological representations onto linguistic structures were extended to cover all the contents in the final version of project ontology. A mechanism was added for verbalizing entities -e.g. locations- and concepts beyond those modelled by the ontology, thus facilitating the portability of the developed components to new emergency scenarios.

Linguistic surface generation evolved to maximize trainable and language-independent methods based on Universal Dependencies (UD), thus simplifying multi-lingual support. Producing longer texts required the development of linguistic aggregation and pronominalizations mechanisms to produce fluent reports and summaries.

The texts produced by the multilingual report generation module in its final version can range from a sentence to a few paragraphs and describe incidents detected by the beAWARE platform along with objects being impacted, locations and states.

Obj.7 – Research & development of Main Public Safety Answering Point (PSAP) for emergency multimedia enriched calls Develop a PSAP

In the context of beAWARE a main public safety answering point (MAIN-PSAP) was designed and developed in order to provide a platform for integration of multiple unconnected security applications and devices and control them through one unified user interface. Special effort was made to improve user experience with emphasis on how user receives snapshot at any given moment for decision makers to enhance the situational awareness. Especially at the final version of the platform the emphasis was given to the improvement of the visual design of the UI and the interoperability of the platform, by refining the appearance and functionality of the task management, making the dashboard more comprehensive, with improved and interactive charts and by enhancing the appearance of the map, with more layers and filtering options.

Obj.8–Design and execute 3 large scale pilots

During the lifespan of the project, beAWARE platform was tested on filed through three large scale pilot exercises. Each Pilot was carefully and extensively prepared by defining:

- The relevant use cases for each pilot.
- The scripts for each pilot.
- The external participants of each pilot.
- The evaluation methodology that will be used.

Each Pilot provided valuable conclusions regarding the performance of each component and the platform as a whole and additionally, provided useful experience for the preparation of the subsequent Pilots, ensuring their successful realization. Special emphasis, for example, was given to the 2nd and 3rd Pilot in order to increase the number of participants and the involvement of First Responders and stakeholders.

3 Main Results

The project started with the definition of the use cases and requirements and setting up the technical infrastructure for all modules. Three main use cases were designed relevant to heatwave, fire and flood and based on these the user requirements were extracted. Based on the user requirements, the technical specifications were set and the platform architecture was designed. This architecture was realised by an operational prototype, which integrates the skeleton versions of the modules and served as fundament for the subsequent work in the project. Additionally, a logger demonstrator interface has been developed to monitor and demonstrate the interoperability of the platform and the messages that are being exchanged between components. The next step was the definition of the pilot use cases setup for the testing of the first prototype and in parallel the development of the first prototype version integrating the initial versions of the project modules, respectively. The pilot testing was followed by the evaluation of the first prototype version, which was conducted according to a pre-defined evaluation strategy, provided the consortium partners with a number of constructive and important insights on how to improve, establishing a good basis for the next development cycle, allowing in addition the update of requirements and the reformulation of the evaluation plan towards the second prototype. The implementation of the beAWARE second prototype version allowed the integration of the advanced versions of the ingredient modules and showed many improvements to already existing functionalities based on the findings from the evaluation of the first prototype. Furthermore, new services were introduced such as the drones platform and the drones analysis module to analyse the input from this platform. The feedback from the second prototype's evaluation was very constructive and led to very helpful and important insights. The analysis of the evaluation results by the consortium led to the finalization of the user requirements and the definition of the final set that driven to the last development cycle of the project. Thanks to the executed pilots, the feedback collected and the joint evaluation study the consortium contacted the integration process in the final phase was streamlined. The implementation of the Final System, integrating the final versions of the beAWARE modules was followed by the final evaluation round, which showed very positive results for all the three beAWARE use case scenarios. A higher number of participants were involved in this third and final testing demonstration than in the previous two. Generally, the PSAP, the mobile application and the interfaces of the different modules were seen as user-friendly and easy to use. Despite the difficulty of adopting technology easily people who interacted with the platform, from different professional backgrounds, found the technology compelling and were satisfied with the beAWARE usability.

The project's results in the context of the individual scientific Work Packages (WPs) of beAWARE are presented in detail in the next Sections.

WP2 - Climate disaster management requirements

The purpose of this WP is to define the user requirements that will lead to the system development and to the use cases definition.

In the context of this WP, a set of beAWARE reference scenarios and use cases were determined. The requirement analysis study was accomplished in 5 basic steps:

1. process analysis with key stakeholders and end users;
2. set-up of non-functional requirements;
3. definition of user requirements;
4. requirements communication; and
5. identify the legal and security requirements of the requirements.

With respect to the Weather forecasting specifications, FMI was responsible for the assessing all the requirements for the data service, selecting the data service and documenting the technical interface between the data service and the beAWARE platform. The outcome was to identify which meteorological data can be available and in which format and how they can be integrated into the system. In addition to basic meteorological forecasts also ensemble forecasts were selected to be used. These are 15-day probabilistic daily forecasts of air temperature, humidity, wind and precipitation produced by ECMWF Ensemble Prediction System (EPS) and calibrated at FMI. Furthermore, open data and criteria of national heat warnings issued by AEMET (Spanish NHMS) were assessed and more specifically, for the forest fire pilot, the usability of existing (JRC) EFFIS service was studied.

Regarding the definition of User Requirements task, a four-step work was conducted. This work was targeted to meet the identified user needs for the respective user requirements. In each subsequent cycle, building upon the previous evaluation of results, the requirements specifications were adjusted according to the findings, as well as recent market developments. The updated requirements guided all the development activities up to the final system. The main outcome of this task was a list of 98 user requirements which corresponds to the 3 Relevant use cases

The Pilots set up task involved the following: 1) detailing the scenarios, 2) collaboration between technology partners and end users, deployment of ICT solutions and addressing restrictions, 3) finalizing use cases and user requirements for the second and last version of beAWARE system and all pilot testing, 4) final review of test strategy and use cases with technical and research partners ahead of operational testing. After the execution of each pilot, adjustments in the preparation phase for the next pilot were made, based on the outcome of the evaluation and the feedback collected.

In the context of the pilot evaluation, the evaluation procedure was configured as an iterative spiral process strictly related to the implementation of the system. Each beAWARE prototype was tested by the end users and stakeholders and their feedback recorded in the evaluation reports (D2.4, D2.6, D2.6) and taken into account for addressing the implementation of the next prototype

Finally, the ethics and privacy task aimed to identify the privacy and ethical issues that were arisen during the generation of user and system requirements. Specifically included the

anonymisation of sensitive data, identification of private data that require security protocols, as well as ethical issues surrounding the development and testing procedures.

WP3 - Early warning generation

The objective of this WP is to provide the necessary technological solutions that will allow beAWARE framework to provide early warning and decision support to the PSAP.

The crisis classification (CRCL) task is dealing with the identification and classification of crisis events based on 1) data from weather forecast, 2) data from heterogeneous sources, including photos, videos, social media content, etc. and 3) rules that can be defined with the help and guidance of user experts. The data from weather forecast and first responders input is aggregated and indexed into a common indexing platform. Mappings are being generated in order to allow for the direct linking of heterogeneous digital evidence and reveal semantic hidden relations. The output of this task is a two-layered crisis classification system, in the first layer of which early warnings are generated while in the second layer, real-time monitoring of an identified crisis event's severity level is performed

Another task with respect to this WP dealt with the concept and conceptual relation extraction from textual information. This task involved the analysis of textual material (texts, SMS messages, social media postings, and transcribed spoken language) with the goal of the extraction of concepts and conceptual relations that encode the content of this material that are fed into the ontologies (WP4). The outcome of this task involved the development of a multimedia text analysis module. The first implementation of this module was limited to the texts used in the 1st pilot. It included NLP tools with multilingual support, i.e. deep syntactic dependency parsing but the extraction of contents and their mapping to the ontology was done in an ad-hoc manner. Since then, a mixture of off-the-shelf IE tools and methods developed fully or partially for beAWARE were incorporated into the MTA module. The version of MTA for the 2nd prototype included several IE tools, namely NER, statistical term detection, geolocation and disambiguation. At that point the textual analysis was capable of identifying heat-related incidents in Greek and English texts, and flood-related incidents in Italian and English texts. In addition to incidents, MTA also detected various types of vulnerable objects - persons, vehicles, etc.-impacted by the incident, and geolocated places associated with the event. In the 3rd and final version the coverage of the module was expanded to go beyond the detect concepts and locations found in several well-known knowledge bases and geographical databases, beyond pre-scripted lists of concepts and locations

The task of concept and event detection from multimedia deals with the analysis of images, videos and audio. With respect to the visual information extracted from video or images this task has developed techniques for detecting specific concepts and events using a machine learning framework trained with visual features. As it concerns the audio information the outcome of the task was an Automatic Speech Recognition (ASR) module to transcribe speech for 4 supported languages in noisy environments. To this end, appropriate concepts and events relevant to crisis management were identified in close collaboration with end users.

Regarding the Visual Analysis component several modalities were integrated even from the 1st prototype, including a fire and flood detection system, as well as people and vehicle detection that may undergo danger during flood or fire emergencies. Until the end of the project an array of cutting-edge computer vision and machine learning techniques has been deployed including 1) image classification, to determine which images/video frames contain an emergent event or not (i.e. a fire of flood event).2) vehicle/pedestrian detection and traffic management, 3) Face detection, to accurately count persons in crowded indoor, 4) dynamic texture localization to localize fire or flood dynamic textures in videos. 5) Internal validator mechanism, 6) Image classification, to detect smoke inside images and videos, 7) Object detection and tracking for classes of animals, specifically cats and dogs, 8) Object detection and tracking for wheelchair users. Finally, a Visual River Sensing (VRS) module was added, to perform visual analysis on footages from static surveillance cameras installed by the river to estimate the water level and generate automatic alerts,

Automatic Speech Recognition (ASR) module was built up on an open-source CMU platform and uses open-source acoustic and language models and dictionaries. At the first prototype, ASR was able to analyse audio messages from the mobile application in order to extract speech transcriptions in the four supported languages of the project. At the second prototype, the Italian model was finer adapted, using case specific Italian audio recordings. Additionally, audio analysis was extended to include emergency phone calls. For this reason, a call center solution was integrated to beAWARE, able to handle calls, record them and forward audio recordings to ASR. At the final prototype, the focus was on the Spanish language, by expanding the Spanish language model and dictionary in order to include more location names. The recognition was also enhanced by improving audio quality during audio conversion at the input of the module and by integrating more robust noise removal algorithms. For the needs of the Fire Pilot (3rd Pilot: Blended Phase), in collaboration with PLV, their dedicated call center was integrated to beAWARE and emergency calls were fetched and transferred to ASR component.

Finally, one additional service was implemented in the context of this WP, although not foreseen in the Description of Work (DoW). More specifically, a drones platform together with a drones analysis module was developed in order to meet the need for providing aerial imagery to the system. The drones platform is a service to connect providers of drones, drones' services, and customers, to easily configure, launch, and monitor drone related activities. The platform consists of 3 components: 1) the Drones server, 2) the Drones edge device, 3) the Platform Dashboard. The essence of the drones platform capabilities is the combination of route planning and drones agnostic autonomous dynamic piloting, with the provisioning of data and metadata collected by the drone, making it available to the beAWARE drone analysis component. Drone analysis is a visual analysis component based on deep-learning visual analysis techniques. It receives drone footage and performs visual analysis to detect people, track vehicles in danger and detect crises, such as flood, smoke and fire.

WP4 - Aggregation and semantic integration of emergency information for decision support and early warnings generation

The objectives of this WP are to collect, aggregate, and semantically integrate content relevant to emergency information, in order to facilitate decision support and early warning generation

The objective of the social media monitoring task of this WP is to crawl the web and especially social media such as Twitter in order to identify user generated content that could support the detection of emergency events, such as flood, fire and heatwave incidents. An appropriate social media crawling infrastructure was set up to constantly run and the collected information is processed with the text analysis and content extraction techniques from WP3. In addition, incidents relevant to emergency situations are extracted by applying a clustering-based approach. Social Media Monitoring comprises two individual modules: Social Media Analysis (SMA) for crawling and validating Twitter posts and Social Media Clustering (SMC) for grouping tweets in a spatiotemporal manner.

Next in this WP is the task for Monitoring machine sourcing information from IoT and M2M platforms. The objectives of this Task were to monitor emergency situation based on data retrieved from M2M and IoT platforms. In the first half of the project, beAWARE delivered the FROST-Server (initially called SensorThings API Server) to store all the time-series data for the project. This contains sensor measurements (e.g. coming from weather stations or water level gauges), water level predictions (coming from AWAA AMICO system) or weather forecasts (coming from FMIs weather models). In the following cycle of the project, additional data sources were integrated and the existing ones were extended. To analyse the data of the FROST-Server a visualization tool was introduced to also cover the newly available data.

In the 2nd half of the beAWARE project additional data sources were integrated in the FROST or the existing ones were extended. Moreover, the GeoServer, a GIS-Server to host geospatial data, was introduced. Thus, next to time-series-data (stored in the FROST-Server), multimedia files (stored in the object store) or semantic data (stored in the knowledge base) GIS data is also available to allow a seamless integration of risk maps that are offered through a standardized interface.

In the Semantic representation task, beAWARE initially focused on studying existing ontologies and standards to form the basis of the beAWARE ontologies and to identify which can be adapted and/or extended, according to the project's needs for semantic representation and reasoning. Then, relying on previously used and validated ontologies, such as PESCaDO ontologies [Rospocher & Serafini, 2012] for the representation of environmental and meteorological conditions, the MOAC [Limbu, 2012] for the representation of disaster impacts, SKOS [Miles& Bechhofer,2009] to import the Simple Knowledge Organization System and the approach proposed by the OASIS project [Couturier & Wilkinson, 2005] for representing mission assignments to units and associating missions to incidents taking place during a crisis, the 1st version of the beAWARE KB (ontology) started to form. Then and after some iterations in the implementation process, the most mature version of the ontology was

deployed on the WebGenesis triplestore and used to semantically integrate the available results of analysis components and task information of first responder teams. Until the end of the project and according to the further development of the other beAWARE modules, the ontology was continuously extended and refined with new concepts and relations. The additions made had the purpose to semantically represent the extended recognition capabilities of the analysis components. This includes for example new subclasses of the VulnerableObject concept, like bicycles, animals, people in wheelchairs which the final version of the visual analysis module can detect. A further set of changes came from the integration of a model that allows describing the different stakeholders that are involved in a crisis as well as the different actions that they can offer to mitigate certain impacts

With respect to the Reasoning for decision support task, beAWARE incorporated a semantic reasoning mechanism to infer underlying knowledge and discover links between incidents during a crisis. This mechanism is rule-based, implemented as a system component with a combination of Python code and an elaborate SPARQL ruleset. This component, called Knowledge Base Service (KBS), acts as an intermediate layer between the WebGenesis triplestore and the rest of the beAWARE modules. At first, a basic layer of SPARQL-based rules “on-top” of the KB was implemented. The tasks handled by the reasoning mechanism were the following: Calculation of incident severity; Spatial clustering of incidents; Monitoring of safe locations; Number of humans and objects in danger; Location of an incident with most involved participants; Which incidents occurred during a specific time period. The set of rules will be further extended after the pilot demonstrations.

In the second iteration the Knowledge Base Service was updated. A richer layer of SPARQL was implemented, GeoSPARQL support was integrated as well as other external semantic resources like WikiData to display points of interest on the risk maps. In the third version the KBS was further improved in order to integrate the incident data captured by Drones and new metrics calculated by the Crisis Classification component. Moreover, a two-layer validation system that targets to protect the system from malicious or incorrect data was introduced, where the first layer takes place individually at the Visual Analysis and Social Media Analysis components, and the second layer operates closely to the Knowledge Base Service and Crisis Classification component taking into account the overall situational picture. In addition to the automated analysis, processes of the beAWARE system, different user interfaces have been integrated into the KB, which shall enable analysts or decision makers to conduct a further analysis and exploration of the data either during the event or afterwards. The interfaces for navigating through the semantic content together with the access to the river level measurements were the first to be designed and implemented. For the final system two other views the Analysis Workbench and the Incident Map and Table were additionally integrated. The analysis workbench was developed to enable analysts to search for specific information in the data that have been collected since the beginning of a crisis. Incident Map and Table are two complementary visualization tools that gives better overview of all incidents with their respective number of detected humans, animals and objects to be easily sorted and displayed in

WP5 - Multilingual report generation

The goals of this WP were to provide technologies for multilingual generation of emergency reports that could be used to support authorities in decision making.

Regarding the Empirical Study of the field task the purpose was twofold. Firstly, the empirical study of the material focused on the determination of the types of reports that were to be generated and the study of their characteristics Secondly, and based on the outcome of the previous step, a number of sample“gold standard reports” were written manually as basis of the work of the next tasks. The results of this task were summarized in the deliverable D5.1.

The second task within this WP, the Setup of the report generation infrastructure, involved the integration of the report generation framework into the beAWARE infrastructure. In particular, this task defined and implemented the service for the access off and navigation in the ontological repositories and the mapping between ontological structures and conceptual / semantic structures of the type accepted by UPF’s linguistic generators used for rendering the text plans produced Task 5.3 into reports in the language of the preference of the users.

Content selection and report discourse structure planning task aimed at developing methods for projecting ontological representations onto linguistic structures that could be used as a starting point for linguistic generation, and for deciding the selection and overall organization of contents in the knowledge base to be communicated in textual form to end users of the beAWARE platform.

During the course of the project, the selection of what contents -i.e. clusters of incidents and associated info- were to be communicated as multilingual reports was assumed by the crisis classification and semantic integration and reasoning strategies. This led to dropping research into content selection metrics reported in the previous periodic report and instead focus on developing methods for mapping from ontological to linguistic representations.

The methods derived for the mapping not only have a complete coverage of all concepts and conceptual relations in the project ontology but also are capable of facilitating the lexicalization of arbitrary concepts and entities beyond those explicitly modelled by the ontology. More specifically, entities and concepts are verbalized using multilingual lexicalizations found in lexical databases such as BabelNet and GeoNames, and integrated in the linguistic structures fed to the surface realization component in a way that they do not disrupt grammaticality nor fluency of the final report.

Basic mechanisms for removing redundancy were extended for the production of wrap-up summary reports, grouping together incident clusters by several criteria -chronological order, incident type, type of impacted object, location- in preparation for the application of linguistic aggregation methods.

The Multilingual linguistic surface report generation task consisted in developing methods for producing grammatical and fluent multilingual text describing incidents or clustered incidents, the vulnerable objects impacted by them, the locations in which they take place and the state in which the incident is at reporting time. During the first reporting period, a stochastic and a

graph transducer-driven linguistic surface generation tools were developed set up and adapted to the production of short reports providing situational updates to authorities. These two tools have evolved towards a single combined generation system using both grammars and trainable methods, the FORGe generation system.

The methods for report generation have been improved in a number of ways. First, the language-specific generation graph transducer grammars have seen a significant widening of the coverage of input configurations and linguistic realization choices. A new linguistic aggregation and pronominalization grammar was added to improve coherence and fluency of longer summaries situational updates. Finally, a new state-of-the art multilingual neural linearizer was developed and trained on a UD-based dataset developed for this purpose.

The final version of the beAWARE generation technologies makes use of the FORGe generation system, which has been largely improved during the course of the project and now achieves a relatively large coverage, in particular for inputs proceeding from structured data repositories such as BabelNet. The coverage of this generator is limited to the project pilots for Italian and Greek, but has a much wider coverage for English and Spanish, meaning that adding additional emergency scenarios in these languages should be greatly simplified.

Dissemination-wise, over half a dozen scientific papers and two shared task system descriptions have been published presenting the datasets and generation techniques. Two shared tasks on multilingual surface realisation tasks and corresponding were organized to give visibility to the linguistic dataset developed within the scope of beAWARE.

Finally, the task for the evaluation of the emergency report generation was carried out in two major evaluation stages after the second and the third pilot respectively. Both evaluations were based on both automatic quantitative and on manual qualitative evaluation methods. The results were reported in three deliverables, D7.6, D5.3 and D7.9 following the self-assessment plan detailed in deliverables D1.1. and D3.1 and in relation to the metrics, baselines and expectation set.

WP6 - Main Public Safety Answering Point for emergency multimedia enriched calls

The objectives of WP6 is to develop a unified platform to serve as a means for public safety answering point (PSAP) to obtain situational awareness and a common operational picture before and during an emergency, and to enable efficient emergency management based on a unified mechanism to receive and visualize field team positions, incident reports, media attachments, and status updates from multiple platforms. The work was based on 4 main pillars:

1. Collecting and correlating multimodal events coming from disparate data sources
2. Video management
3. GIS analysis
4. Incident and resource management

One of the main objectives of this work package was the design and development of advanced presentation layers based on cutting edge GIS, analytic and visualization techniques.

Initially and within the first task, an extensive research was made to identify novel interaction techniques and examine new presentation concepts in data analysis. This research aimed to improve operator focus and efficiency through examination of new presentation concepts in data analysis, focusing on temporal data exploration, finding anomalies in event sequences that can potentially lead to process improvements and management practices.

Data Source Integration Framework task objective was to ensure robust and reliable integration of data sources. This task developed suitable support frameworks to create the integration layer reside on top of varying physical infrastructures to expedite the integration of existing and new data sources. By providing this abstraction from the underlying data sources, it provided a framework to intelligently manage the data and control flows between the beAWARE platform and the physical environment.

Finally, the Main public safety answering point task was responsible for the development of the main public safety answering point (PSAP). In the 1st version of the PSAP the integrated development environment (IDE) was set up together with a codebase organization, build service, feature and issue tracking, and a test environment. In addition, the messaging functionality was established on top of the Message bus and combined with a basic map-based visualization functionality. In the second version of PSAP, the visualisation map and the incident clustering mechanism was improved according to the recommendations of the 1st Prototype evaluation, including raw and analyzed media like images, videos, and audio, stacking multiple media files from different incident updates. Also, the first version of the Task and Operation manager were presented. In the final version significant efforts were made for optimizing the navigation fluidity and the user experience, with alerting notifications, use of humanitarian icons, and differentiation of icons per incident type for better understanding.

WP7 – System development, integration and evaluation

The goal of this WP is to conceptualize the architecture and design specification of the beAWARE platform as to integrate the individual results from the work packages WP2 – WP6. The system architecture is a modularised blueprint for the platform's construction, detailing how the software components involved will be put together and subsequently deployed. The principal aim of the architecture is to facilitate the initial design and development of the platform, by providing detailed enumeration, specification, and means of validation that each of the components built, meets the needs of the other components, or actors, using them.

System Requirements and Architecture task aimed to derive and document the conceptual architecture and detailed specifications of the beAWARE platform. The architecture of the beAWARE platform describes in detail the integration logic and interfaces between the involved tools, modules, and services. This task started out by translating end users functional and non-functional requirements into system requirements. The architecture specification was created to address these requirements. Due to the distributed approach of the design and implementation of the beAWARE platform, according to which different partners develop

independently and maintain ownership over different components of the system, combined with the complexity of the platform, which is comprised of many different components, it was followed a micro-services approach to make the entire process of design, implementation, and integration more manageable, in a distributed manner. After the analysis of system requirements and architecture and as the task finished, all the technical requirements regarding integration platform were clarified (CI process and K8s cluster).

With respect to the platform tools task beAWARE integrates the developed software components from the technical WPs, to form the final beAWARE platform. From the very beginning an integration plan was prepared to guide the integration of the beAWARE components. Initially, a basic integrated beAWARE platform (R1) was delivered realizing the platform as a whole, but with limited functionality. This mainly involved the integration of the software components that constitute the beAWARE system. In the following periods the project teams focused on extending and refining the initial services that were introduced for the successful delivery of the 1st version of the beAWARE platform.

Additionally, the following subtasks were achieved.

1. The components were deployed through the CI process.
2. Access was given to the CDR (platform's object store).

The back-end of the beAWARE is deployed on the IBM cloud, providing a 4 nodes Kubernetes cluster on which the individual components are deployed. In addition, several data stores providing different capabilities are deployed on the cloud and are accessible by all system components. Finally, a message bus is established on the cloud to enable easy communication among the different microservices.

The Overall Technical Testing of beAWARE platform task involves all activities related to software testing and evaluation of the beAWARE platform. Testing proceeds through the following cycle: a subset of tests is executed to validate that the prototype is stable enough for detailed test and evaluation effort to commence, intensive tests are implemented, executed & evaluated against testing objectives (additional testing is done as necessary) and test methods were improved as needed to support the next cycle of testing (final prototype). In order to conclude about the technical evaluation, it is noteworthy to refer to the extended efforts of testing that were committed upon, through teleconferences among partners, to solve intra-communication problems as well as internal functionality misbehaviours. At project integration level, the consortium used weekly plenary WebEx meetings to provide updates on the current status of the different parts of the project in order to accomplish specific deadlines following a SCRUM testing methodology. After the finalisation of each of the integration cycles a video demonstration was created capturing at each iteration the functionality of the platform. Three videos were prepared in total and are available on the beAWARE website.

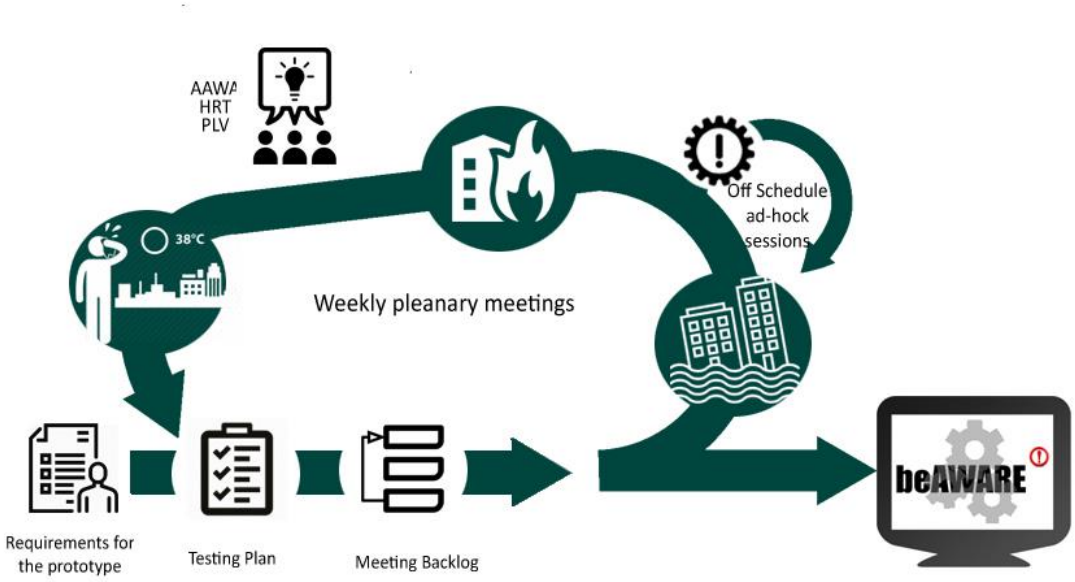

Figure 1:Testing and Evaluation Methodology

Extensive work was carried out within the task Communication infrastructure deployment for defining the set of topics which were used by the different components. This task required the understanding of inter-component interaction, namely which components need to feed information to other components. That process led to the establishment of subscribers and consumers for each established topic. Moreover, once the topics were agreed upon, their structure was defined so that the components interacting via the message bus could understand each other. The messages format was broken down to a common header, which included information required regardless of eth specific topic at hand, and an extension which was specifically tailored to the needs of all components using a specific topic.

Finally, the End-users applications task involved the design and development of software applications used by citizens and FRs. The result of this work is software applications to support people in need to make emergency calls to the system. The type of messages that can be inserted to the system via these applications are video, text and voice messages in a two-way communication manner, meaning from and to the PSAP center. In the first prototype delivered a basic version of these application for sending multimodal reports and receiving public alerts. For the second prototype, the app was extended with team and task management functionality. In the final version the team functionality was extended to support all the project languages. Public alerts reception from authorities was enabled by role (citizens/first responders) and profession (fire fighters, police, …) and the alerts were considered as geo-fence virtual perimeters with real-world geographic representation that trigger notifications to the mobile app of the users when crossing the physical area that is defined by them.

WP8 - Dissemination, exploitation and impact

The objectives of this WP were to develop a multi-dimensional communication and dissemination plan and promote the project's developed services and outcomes in order to increase awareness among project's stakeholders and the general public, to provide viable business models that will lead to the long-term sustainability of the proposed approach involving all actors of the value chain, to plan and verify the exploitation potential, during and beyond the end of the project progress.

The Dissemination and Communication task included the elaboration and update of the beAWARE Communication and Dissemination plan and the organisation and implementation of the project's (major and minor) dissemination activities/events. The Communication and Dissemination plan was to identify the project results and assets in order to have a high dissemination and exploitation potential, to the relevant target groups, the means/tools from the channels of dissemination. An annual basis update of the plan took place plus ad-hoc when necessary in order to assist project consortium as well as individual partners to maximize the impact of their dissemination actions. Potential synergies were defined and some of them were updated, in order to enhance the dissemination range and impact. Given the potential of beAWARE for a wide range of stakeholders, such as first responders, PSAP operators, European technology providers, dedicated outreach activities took place and were implemented such as the organization of a workshop, the presentation of partners in relevant events and conferences, and the publication of several scientific articles/papers in academic journals and conferences.

In the following, all the dissemination activities are presented that took place during all the project, which include:

1. 64 participation in conferences and events and workshops,
2. 40 meetings with stakeholders and user groups
3. 43 publications by the consortium in conferences or journals.
4. Organization of 2 international workshops during ISCRAM 2018 & 2019
5. 3 Info Days

More detailed information on the dissemination activities for the first year of the project can be found in Deliverable D8.3.

The Online & offline communication and dissemination material task aimed at the design and implementation of the project's website and other relevant online communication tools, and the creation and periodic update of the offline dissemination material.

At the first period of the project, HRT designed and provided for the project a communication kit containing a **flyer**, a **factsheet**, a **poster** and an overview PowerPoint **presentation**. All these offline communication materials were then distributed, to all the partners of the consortium to be used in their dissemination activities, during all the period of the project for dissemination purposes (eg meetings with stakeholders) and at conferences, workshops etc. throughout the last period of the project. Additionally, more promotional material, like USBs, notebooks, folders, eco-friendly bags and vests were created to be distributed and used during the pilots.

To add more, the **website** continued to be used as the dissemination tool among the beAWARE consortium and the audience interested in the project. Moreover, the project's wiki was used as a management tool among the project partners.

Additionally, social media channels continued to support and spread useful information about the beAWARE project. During the second quarter of the reporting period, three dedicated to beAWARE social media accounts were created (**Facebook**, **Twitter**, **LinkedIn,**) and later on after the implementation of the first pilot a **YouTube** channel was created as well, in order to promote the project's activities and the platform to the general public and to experts in order to generate and enhance their interest in the benefits of the platform, its technologies and developed tools.

The decision made in the previous reporting period, that all posts on the online platforms will have one of the following subjects, applied to this one as well:

- Updates related with the project's activities and plenary meetings
- News related directly or indirectly to the potential use of the system (e.g. natural hazards, extreme weather conditions, etc.)
- Invitation of followers to the Network of Interest list
- Promotion of the dissemination material of the project, such as newsletters, brochures, etc, as well as the beAWARE's website
- Events that the projects will organize and plan to participate (such as conferences, workshops, etc.)
- Any news regarding the pilots of the platform and, in the upcoming future, of their set-up.

To add more, **newsletters** of the project continued to be published and inform on the one hand our Network of Interest but also everyone who was interested in the project, for all actions that took place. All newsletters offed information about the project's progress and news, some information about the technological developments that took place in the framework of the project and also other news relating to events caused by extreme weather conditions.

At the same time, the social media accounts and the website were enriched with the latest developments regarding the **project** and relative **news**.

Furthermore, the project's PowerPoint presentation used for dissemination purposes was updated based to the latest developments and with the addition of the poster that was created in the previous period helped at the promotion of the beAWARE project in **workshops** and **conferences**. Moreover, videos were created in order to promote the project and its activities. The videos that were produced were focused on the following areas:

- Project presentation
- To show the system's functionalities
- Interviews

- What happened during the pilots

More detailed information on the online & offline communication and dissemination material for the first year of the project can be found in Deliverables D8.3 and D8.6.

The task referring to the beAWARE network of interest was aimed to identify and establish a Network of Interest (NoI) which consisted of relevant stakeholders (i.e. first responders, PSAP operators, European technology providers, emergency services organisations, research and development laboratories). The purpose of the Network of Interest was to gather and actively involve those relevant stakeholders and potential users of the platform to facilitate productive communication and feedback regarding the platform and its applications. The main idea behind the Network of Interest is to exchange information, ideas and thoughts about the beAWARE platform and to give members the opportunity to improve their understanding on the project, as well as to create the ground for the exploitation and long-term sustainability of the beAWARE project

Early enough partnership has shown as a priority task to set up a Network of Interest consisting of stakeholders relevant of beAWARE objectives and activities. It succeeded to set a NoI of 149 stakeholders (see deliverable D8.9).
This communication and feedback that was achieved by engaging with the Network of Interest contact list through email communications, newsletters, encouraged them to participate in the online presentations and discussions of the project as also some of them to participate in the pilots.
Participation in the Network of Interest was open and heavily promoted through the dissemination activities of the project. Last but not least, the promotion of the projects activities was being done through Social Media platforms (Facebook, Twitter, LinkedIn, website), where all contacts from the Network of Interest were invited to like, share or follow. The NoI consists of the following (M36):

- Total number of participants in the NoI: 149
- Types of organizations: Governmental Authorities, Local Authorities, First Responders, NGOs, Institutes, Universities, Industry, SMEs, PSAP.

Table 2: Noi: Type of Organisations

Type of Organisations	Frequency	%
Government	43	28,9%
Local Authorities (LRAs)	12	8,1%
First Responders	29	19,5%
Emergency PSAP	3	2,0%
Industry	19	12,8%
University	12	8,1%
Academia	4	2,7%
Institute	14	9,4%
TOTAL	13	8,7%
	149	100,0%

Around twenty countries are represented in the NoI list, with the vast majority coming from Spain, Greece and Italy but with a very promising representation of countries outside the European Union, such as USA and Switzerland.

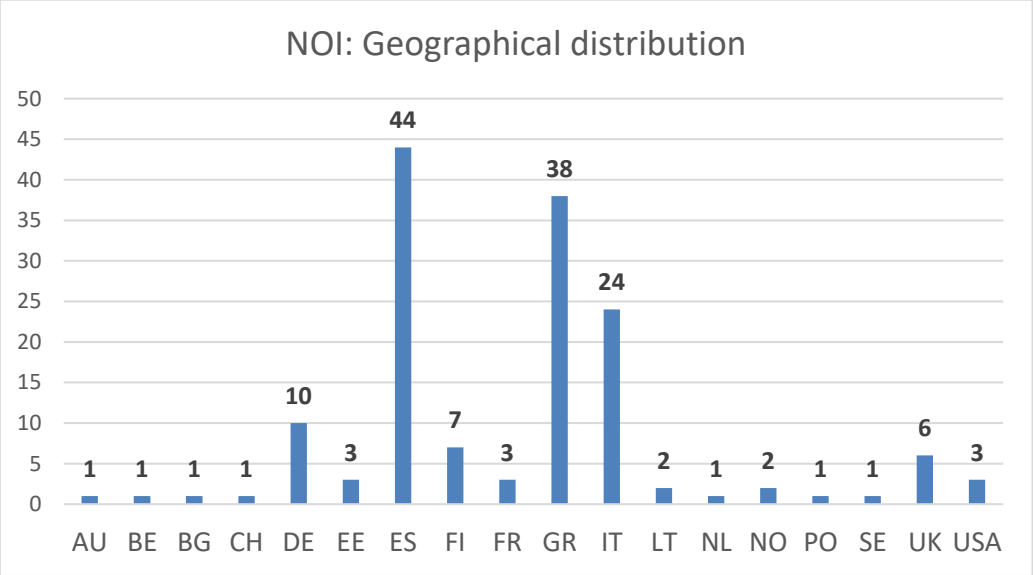

Figure 2: Noi: Geographical distribution

More detailed information on the Network of Interest plan and activities for the last year of the project can be found in Deliverable D8.9.

The purpose of the Overall Impact Assessment task was to clearly present the benefits of the beAWARE solution for the different stakeholders groups. An analytical review of the overall impact of the project was conducted during the last period of the project.

The overall impact of the beAWARE system can be seen from the results of the three evaluations which present the continuous and increasing positive impact from the different target groups after all the pilots. The overall impact of the project was analysed in many key noted impacts which are:

- Science and Innovation Impact
- Economic Impact
- Safety Impact
- Training Impact
- Societal Impact
    - Government Authorities/PSAP operators
    - Policy Makers
    - First Responders
    - General Public (Citizens)
    - Conceptual Impact

Finally, the Innovation, exploitation and long-term sustainability plan task included the development of an innovation and exploitation plan. This plan identifies the innovative elements of the project, and monitor and assure through specific actions that the project's

innovative aspects will be sustained after the end of the project. The goal of the exploitation plan was to develop key strategies for the exploitation of the project's main results, explore their wider use and sustainability, and if relevant their business feasibility. In addition, by involving relevant market and innovation stakeholders, beAWARE investigated a wide range of exploitation prospects, the potential for their wider use, and consequently their impact to the economy and society.

After two iterations the formulation of the final exploitation plan was presented. According to that, PLV authorities will host and use the platform after the project ends as a show case. As a result, there will be a place that the beAWARE system will be used in real life situations and events. This will create a demonstration environment for any potential interested party to visit and see the system in actual use.

In order to support the business aspect of the exploitation a joint exploitation plan was formed and a permanent demo environment will be established to demonstrate the use of the system to potentially interested parties.

More detailed information on the innovation, exploitation and long-term sustainability plan of the project can be found in Deliverables D8.13 and D8.14 (Non Public Deliverables).

beAWARE System

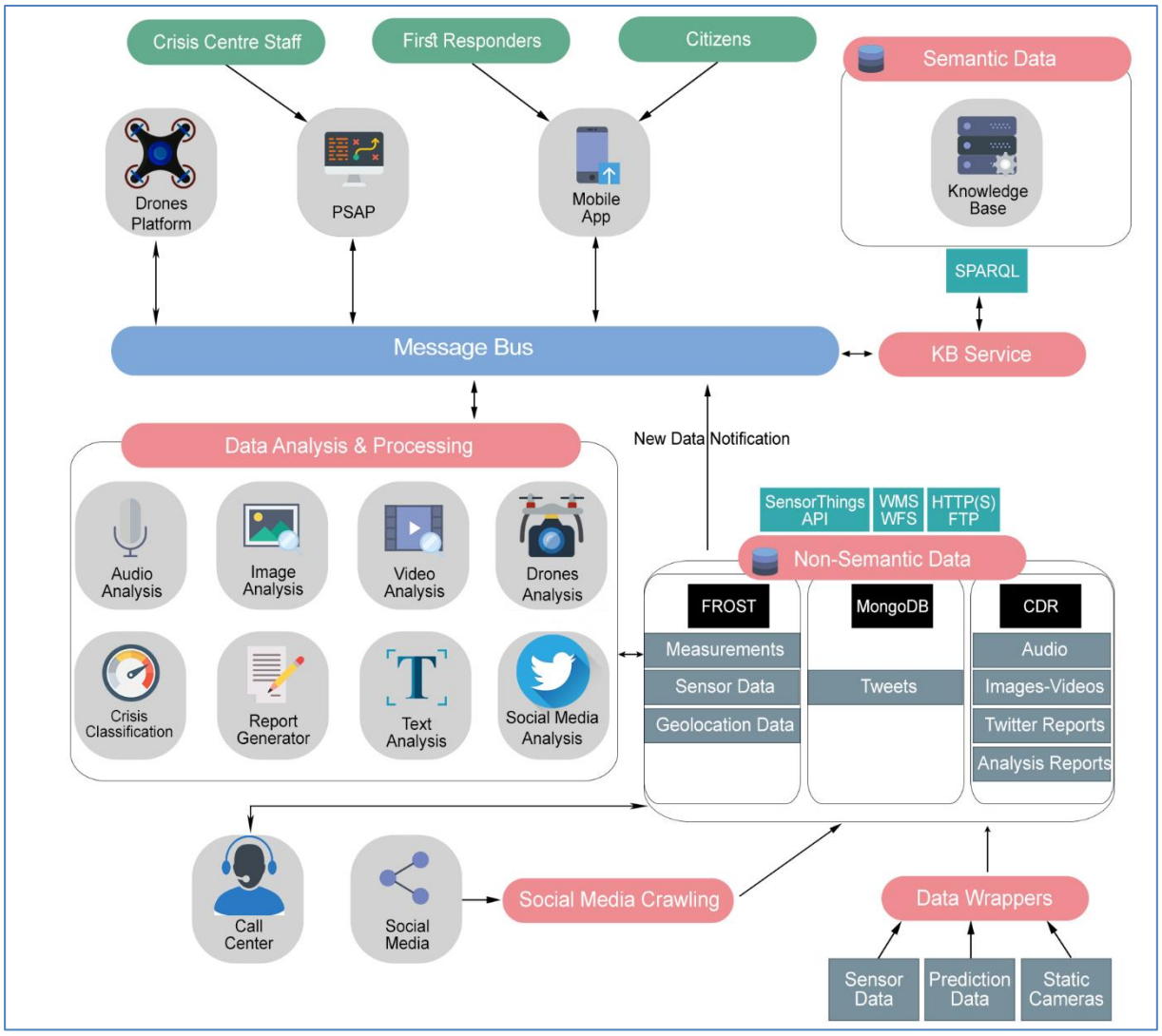

Figure 3: beAWARE architecture

The integration of the beAWARE System involved iterative cycles of development and evaluation, constantly monitoring the integration plan and work, tracking all the issues with relevant tools and assigning the resolution of problems to the responsible module developing partners.

The beAWARE architecture (see Figure 1) is based on a state-of-the-art approach and encompasses the following layers:

1. **Ingestion layer**, containing mechanisms and channels through which data is brought into the platform;
2. **Internal services layer**, is comprised of a set of technical capabilities which are consumed by different system components.
3. **Business layer**, containing the components that perform the actual platform-specific capabilities;

4. **External facing layer**, including the end-users' applications and PSAP (Public-safety answering point), providing the operational picture to the authorities.

After the implementation of the operational prototype of the beAWARE platform, integrating the skeleton of most of the services developed in the context of IO2-IO7, came the next development phases with the implementation of the 1st, 2nd and final prototype of the beAWARE platform, integrating the baseline and the advanced and the final services respectively. The architecture that was defined for the final beAWARE System is presented from a high-level view in Figure 1.

4 Impact Achieved

At the beginning of the project we have defined several key performance indicators regarding project operation (efficiency, progress tracking and quality) and impact. To assess the project impact, we use a number of those KPIs, as well as some additional ones. Those metrics have been derived based on the dissemination and exploitation activities, and the recording of the project IPs and were estimated at the end of 2019, thus reflecting the impact of the project shortly before its completion. It is expected that several of them will be increased in the coming period (e.g. some more journal articles and conference papers will be accepted, papers will attract more citations, etc.

Table 3, presents the obtained scores along with the goals when those were specified in the beginning of the project. It should be mentioned that some of the KPIs were enriched based on the information that can be monitored and that can be used to extract feedback and relation to the dissemination and communication outcome of the project's status. Looking at the mere numbers, beAWARE has fulfilled most of the goals set in the beginning of the project and sometimes even exceeding the numbers, e.g. publishing more articles to scientific papers or participating in more conferences than planned, when in some other cases such as the number of newsletter subscribers, the target has not been met. Nevertheless, even in this case it is noteworthy that in the last year subscribers have more than doubled.

Table 3. List of KPIs – Overall Status

Channel	Description	Content	Source of information	KPI (End of Project)	Overall Status
Project website	Online page which provides general project information for the public, including project objectives, consortium members, public deliverables, news and events, dissemination material, social network links, newsletter subscription etc.	General Project Information.	Google Analytics	20.000 page views	26.311 page views

Channel	Description	Content	Source of information	KPI (End of Project)	Overall Status
Social media activities	Promotion of the project activities and results through LinkedIn, Facebook, Twitter, increasing the visibility of beAWARE	General project information, relevant news with the project scope, communication with other H2020 projects	Social Media page analytics	250 followers	329 Twitter 306 Facebook 55 LinkedIn
Publications	Consortium partners will publish (according to the IPR protection strategy) the results in a journal	Publishable project results.	Google scholars	10 scientific papers published in International Journals and conferences.	43 Publications
Events participation	Project presentation in a number of national and international conferences, fairs, seminars, workshops, etc.	General project information, publishable project results.	Attendance sheets, photo, announcement etc.	At least 5 participations	64 participations
Workshop	Organizing of a European project Workshop: It will take place nearly the end of the project at an EU country in parallel with a respective event with high reputation on emergency services.	Share experiences and lessons learned with stakeholders, and disseminate project results and success stories	Attendance sheets, photo, announcement etc.	At least 50 participants	More than 200 participants in the conference.
Newsletter	A newsletter will be created and distributed every six months, or after any major project event (e.g. pilots etc.) to all identified stakeholders, subscribers and members of the projects NoI list.	All the project updates, news and participation in events and conferences	MailChimp Analytics Project website analytics	300 subscribers +	207 subscribers 7 newsletters 33% opened (mail) 44 av. pageviews (site) Average time on page: 02:03

Channel	Description	Content	Source of information	KPI (End of Project)	Overall Status
					Total Pageviews in **news** section: 871 Average time on page: 01:20
Info Days	There will be training info days organised by the partners who lead the pilots.	They will be aimed at making pilot users aware about the objectives and activities of the pilots, while also training them on using the beAWARE platform.	Participation sheet, public announcement etc.	Three (3) info days will be arranged per pilot	One (1), during the Heatwave Pilot in Thessaloniki. One (1), during the Flood Pilot in Vicenza. One (1), during the fire Pilot in Valencia
Promo Material	Project brochure, banner, poster, project presentation.	General project information	Downloads and number of printing material	300 Downloads[1] • Total Pageviews in Recourses page • Total Pageviews in deliverables page 3.000 items distribution	Total Pageviews in **Recourses** section: 629 Average time on page: 02:47 Total Pageviews in **deliverables** section: 1068 Average time on page: 02:39 1.150 Flyers

[1] The material can also be viewed online

Channel	Description	Content	Source of information	KPI (End of Project)	Overall Status
					200 factsheets 3 Posters 4 banners 8 videos 200 Notebooks & pencils 20 fluorescent vests 110 bags 100 folders Training materials 200 beAWARE agenda book 30 beAWARE badges 200 USBs

In the following there is an analysis of how beAWARE has managed to meet the expected impacts of the call, as they are stated in Section 2.1.1 of the DoA.

Expected impact: *- more effective and faster emergency responses to extreme weather and climate events; Faster analysis of risks and anticipation;*

beAWARE, through the development of early warning mechanisms, which are based in various sources of data and analysis of those data, is able to support a faster response from the authorities and first responders to upcoming events. Weather data analysis provides a weather forecast which is combined with the crisis classification module. As a result, beAWARE provides information to the authorities regarding an upcoming event as also information about its progression during the event's lifecycle. Moreover, information from sensors also support authorities if fast decision-making process. Additionally, analysis that is provided to information that is derived from social media, especial when coming from citizens who are in proximity to an event, allows authorities to provide a more effective and faster response to an event.

This is based on the fact that information reaches authorities faster and it is analysed quicker and in relation to specific thresholds offering at the same time authorities a visual overview of the situation. beAWARE's DSS mechanisms which are based on reasoning, together with a

PSAP which supports a visual overview and analysis of a situation, strengthen the overall situational awareness capabilities of the authorities in order to act faster and more effective.

To support the above statements, the evaluation results for the real time data demand was rated from good to excellent during the pilots of the project. Moreover, the clustering of information from similar events and the deletion of irrelevant ones coming from social media, allows the faster analysis of information and therefore of potential risks during an emergency supporting authorities to focus only on relative information. This was also something that was pointed out by participants in the 3rd and final pilot of the project, which demonstrated the final version of the system. All the evaluation results that support this claim are presented in deliverables D2.4, D2.6, D2.8.

Expected impact: *- publicly available online now- and fore-casting systems for disasters triggered by (extreme) weather conditions; - improved coordination of emergency reactions in the field, including the use of adapted cyber technologies;*

As has already been mentioned in the previous periodic report, beAWARE is not restricted in traditional voice communication but also takes into account other channels, like social media, and analytics which assist a PSAP operator to assess the validity of information as well as the weather forecasting update through the crisis classification module that has been developed during the project. All incoming information from various sources, like weather data and sensors, is analyzed by the crisis classification module of the system in order to provide visualized information to the PSAP and the authorities in relation to the progression of an event. The incoming weather forecasting together with the crisis classification module, depending on the predefined threshold, trigger the early warning mechanism of the system alerting in this way the authorities for an imminent event. In general, the crisis classification and the weather forecast provide the base for the first action during a crisis that is caused by events related to extreme weather conditions.

The weather information can be provided by sources that are publicly available and can be used as an input to the system. For the purposes of beAWARE, the input of weather data was simulated and supported with data provided by FMI.

Furthermore, beAWARE supports efficiently the coordination of emergency reaction in the field though the use of cyber technologies. As it was stated by first responders who participated in the pilots, beAWARE allows overcoming various issues noticed with legacy tools inside the city, such as bad radio signals, interference, and misunderstanding in operational procedures caused by miscommunication. beAWARE has proven that it supports the flow of communication between authorities and PSAP on one side and first responders who are on the field on the other, through the use of a mobile application that provides targeted information to relative target groups. Moreover, the functionality of task assignment and the overall task management of first responders through beAWARE's PSAP, also improves coordination of emergency reactions. The operator of the PSAP is able to see the location as well as the status of each first responder team on the field in real time and simultaneously for all field-teams and at the same time is in a position to assign tasks to specific teams and receive

feedback from them relating to information from the field, thus improving the coordination on the field. This feedback, is not limited to written or speech communication, but it can also be an image or a video sent from first responders who are on the field, to PSAP and the authorities so that they (authorities and PSAP operators) have a direct knowledge of how the situation on the field is, as well as on how an event is progressing, hence being able to coordinate field teams more productively.

To support the above, participants in the flood pilot, including the decision-makers at the PSAP, first responders on the field and citizens as well, pointed out that the value that the continuous flow of data and information, before during and after the event, supports effectively the coordination and communication requirements. Additionally, effective coordination between the different groups was stressed on several occasions by participants in the fire pilot hence supporting the fact that beAWARE can be useful in this regard. A more detailed presentation of the evaluation results of the flood and fire pilot that support the above is included in deliverables D2.6 and D2.8.

Expected impact: *- improved capacity to provide adequate emergency responses to extreme weather and climate events; - shorter reaction time and higher efficiency of reactions;*

beAWARE provides information to the authorities regarding an upcoming event as also information about its progression during the event's lifecycle. All information is analysed and presented to all parts involved in an emergency, like governmental authorities, PSAP operators and first responders in such a way that it is easy to comprehend and extract the core of what is happening. The overall goal is to *improve the capacity to provide adequate emergency responses* faster and *more efficiently*. The information flow of the final system is demonstrated in D7.8.

Due to the fact that potential end-users of the system may come from different fields, from volunteers up to civil protection authorities on any level, beAWARE was developed with in a flexible and adaptive way, in order to support their different approaches, requirements and needs. More specifically, the layout of the PSAP can be modified in order meet the requirements of any operator and pop-up windows offer different level of information. This allows an operator to adapt the system to his needs and not for the operator to adapt to the environment of the system, supporting at the same time the strengthening of the operators' capacity to manage emergency responses using all beAWARE tools.

Furthermore, all beAWARE functionalities that support the decision-making process help an organisation to improve its capacity to provide adequate emergency responses to extreme weather and climate events. More specifically, the early warning mechanism provides an alert even from the stage when an event is imminent. Additionally, the analysis of images, videos, texts as well as information that is derived from social media, allow an organisation to gather and analyse quickly and effectively information from various sources, which are also used by other tools like the Crisis classification Module in order to provide specific and analysed information to the authorities in relation to the management of a weather-related event. Also, the developed drone platform that can be used from field teams and the analysis of

information that are gathered through its use, like the analysis of images and videos, significantly increases the capacity of first responders on the field to manage various events. It is worth mentioning that beAWARE tools can be used also as separate solutions, offering to a potential end user the possibility to increase its organization's capacity by adopting only the tools that the organization requires.

A statement that was made by almost all participants in the pilots and demonstrates the impact of beAWARE in the increase of an organisation's capacity is that beAWARE is a great complimentary system to existing legacy tools, already used. This means that it does not require from an organisation to change and abandon the tools that this organisation uses but it can adapt beAWARE system and use it in parallel with existing systems, supporting this way the increase in its capacity without forcing structural change. Needless to say, that beAWARE is also a stand-alone solution; however, it is recognised that it not limited to that approach.

Increase to an organisation's capacity is also supported by shorter reaction times and higher efficiency of reactions to extreme weather and climate events, an impact that beAWARE also supports. Constant flow, analysis and evaluation of information that beAWARE supports, allows an organisation to react faster and more efficiently when managing an extreme weather-related event.

As reported in the evaluation of the pilots, policymakers and PSAP operators gave increasingly positives opinions (>75%) for the continuous data flow and analysis of information, and especially the provision of real-time data on demand, supported them to take faster and more accurate decisions during all the phases of the crisis, relative to an extreme weather event.

Furthermore, to support this impact that beAWARE had, during the evaluation of the pilots, the vast majority of first responders (83%) also expressed an increasingly positive opinion due to the fact that they also had shorter reaction times, better data quality, from PSAP, a significant improvement of communication between them and the PSAP, which resulted to an increase in efficiency when operating.

Expected impact: *enhancement of citizen's protection and saving lives. The action is expected to proactively target the needs and requirements of users, such as national law enforcement agencies, climate and weather services, civil protection units and public and private operators of critical infrastructures and networks.*

As stated in DoA and in the first periodic report, beAWARE aimed to *take emergency services response even further by developing a framework that will organise and manage more efficiently the crisis, by enhancing the situational awareness and the early warning mechanisms.*

beAWARE covered that impact by making citizens a more active part of the chain of information. The social media analysis tool, analyses, identifies and clusters all relevant post made in social media and that are relevant to an ongoing event caused by extreme weather conditions. The system identifies key words in posts made during a crisis and clusters them if they are located in proximity area with each other.

Through that process, authorities are in position to spot among others, whether citizens are in imminent danger and take appropriate actions danger. Moreover, information that come from citizens though social media and which are sent from a specific incident (e.g. specific posts) and are found by PSAP and authorities through beAWARE, may also result in taking actions for helping citizens that are in danger.

The text analysis and the speech recognition tools that beAWARE supports, allow citizens to communicate with authorities in more ways that the traditional phone and alerting them about critical situation and even if they are trapped in a dangerous situation and require assistance. This functionality was demonstrated during the pilots of the project were authorities received voice messages, text messages and social media posts that informed authorities to take appropriate actions. A good example of how beAWARE supports that impact is the evacuation of the school that took place during the final pilot of the project, resulting in getting a lot of people away from a dangerous area.

Furthermore, through the mobile application, beAWARE delivers public alerts to a specific area in order to inform citizens if an event is in proximity to their location and also sends specific instruction for citizens to follow in order to distance themselves from danger. This action which takes even at the beginning of an event and can be done whenever authorities believe that is required results in citizens getting informed at an early stage in order to take appropriate actions. This process and mean of communication between authorities and citizens is further enhanced due to the fact that citizens do not only receive but are able to send information to the authorities through the mobile application, offering them information about an event that may result to actions that save lives.

All the above have been demonstrated during the pilots of the project and were reported in the evaluation results. All citizen-actors reported that the overall information that they received was from good to excellent as were the instructions that they received through the mobile application. Furthermore, the important role of citizens in sending information before the arrival of emergency services was also mentioned. Additionally, all participants expressed the importance of this platform for citizens, since in this way emergency managers obtain richer information than through other traditional means, while it takes less time to analyse this information thanks to the clustering of similar incidents, reporting, and omission of irrelevant information that is derived from social networks.

The call’s expected impact however is not limited to the enhancement of citizen's protection and saving lives, only by directly influencing citizens, but through targeting the needs and requirements of users, such as:

- national law enforcement agencies,
- climate and weather services,
- civil protection units,
- public and private operators of critical infrastructures and networks

beAWARE's aimed to impact the operations of all users. All user requirements, both on a technical and a functional level were formulated in the beginning of the project. The consortium's end users, along with other stakeholders that were approached by the partners, formulated all user requirements for the system. All partners used their network to support the process and to cover as wider range of users as possible.

All end users and primarily first responders and civil protection authorities have as a first goal the protection of citizens and the saving of lives. Therefore, by covering their requirements, beAWARE develops into a system that supports that goal, hence protecting citizens and their lives.

In order to achieve that and to fulfil the expected impact, beAWARE tested the system and the level that all recorded requirements were met in three separate stages through pilots that simulated real case scenarios, with three extreme weather-related events, heatwave flood and fire. The pilots were also part of the development process, where technical partners and end users had the opportunity to test the system and take corrective actions while developing it further to its next version. In the pilots, apart from the end users of the project other stakeholders participated as well, either as observers or players. In the end of the pilots, discussions on the way and level that beAWARE system meets the end users' requirements were held. In all pilots, the value and impact of beAWARE was recognised since it was generally evaluated as good or excellent system that it complimented legacy tools. Moreover, an evaluation on the level that the user requirements were met after each pilot was held. After the completion of the third and final pilot, beAWARE had met almost all recorded user requirements, covering the expected impact. By covering the user requirements, beAWARE proved its value as a crisis management operational system that can support the management or events related to extreme weather conditions and that it also supports end users by covering their desired requirements in order to help save more lives.

However, beAWARE does not only limit its impact to the impacts specifically referred to the call. Throughout its implementation it has demonstrated its impact in other areas as well, like science and innovation. Furthermore, since the core objective of beAWARE is to support all the phases in a crisis management sequence, its impact in the society is also important.

The overall impact of the beAWARE solution, establishes a well-taken investigation of a wide range of exploitation prospects, the potential for their wider use and of course their impact on the economy as also the society, locally, nationally and in Europe. The evaluation methodology was mainly based on the user perspective, such as PSAP operators, first responders and citizens, and was mainly focused on the impact of the beAWARE solution in life-saving, protection of infrastructure and property, reducing response time and lowering costs. The impact of the system was evaluated by comparing the management of an emergency before and after the implementation of the beAWARE system. This comparison between existing technologies and the beAWARE solution in all three pilots gave the opportunity to identify and record the impacts of the beAWARE system in order to maximize the dissemination actions.

In the following sections the overall impact of the system in various areas is also analyzed

4.1 Scientific and innovation impact

The development of a new system that combines various technologies that answer different requests from end-users' perspective resulted in a noted scientific and innovation impact of the beAWARE technology which is presented in various scientific conferences and research papers. Additionally, innovation elements were highlighted and noted after the pilots upon discussion with the participants.

Moreover, beAWARE had achieved to give effective and faster emergency responses to extreme weather and climate events, with faster analysis of risks. In the three pilots, beAWARE decision support services for crisis management had proven to act with great efficiency answering all different tasks for the three scenarios. In addition to that, beAWARE system successfully improved the coordination of emergency reactions in the field, to address extreme weather events thanks to the combination of reliable and updated meteorological data, provided in our case by FMI as also AAWA's AMICO model and the DSS that was developed by the technical partners. The trigger mechanism that beAWARE developed for the 3 extreme weather events tested in different periods of time for each one (before, during and after the event) resulting in codified messages from the platform to the mobile application, upon Authority decision and request proves the abilities of the platform to assess the validity of information. This combination of technologies and reliable data was proven during the pilots and mentioned at the evaluation sheets and during the discussions (hot debriefs) with the pilots' participants.

In combination with the above ones, beAWARE addresses and the expected impact of shorter reaction time and higher efficiency on reaction due to extreme weather and climate events. This was achieved firstly, thanks to beAWARE KB that estimates the emergency level of the situation in order PSAP operators and first responders to act accordingly. Secondly, due to the fact that beAWARE can continuously receive and analyze data, such as meteorological, sensor (water), video, image, audio, social media (twitter), it gives the ability to decision-makers, PSAP operators and first responders to have higher efficiency on their decisions and calls as also their actions on the field depending on the situation. It is worth to mention that UPF developed an extended text analysis module that can handle not only inputs from its own mobile application but also social media (Twitter) inputs related to the three scenarios, in English, Italian, Spanish, and Greek. To add more, CERTH's automatic support recognition system, image, video, drone and traffic analysis helped in the overall creation of the beAWARE system. Supporting the above functionalities, IOSB provided a mobile application and a SensorThings API which were filtered and notified by the M2M/IoT platform through open and standardized interfaces resulting in the overall formation of the system.

To add more, from the perspective of technology providers and industries as mentioned above, a large positive impact of the beAWARE took place from participation in scientific conferences such as ISCRAM 2019, SmartResilience, Sayso_H2020 EnviroInfo 2018, TRECVID

2018, COWM 2018, European Meteorological Society: Annual Meeting (EMS) 2018, SafeKozani 2018, SemEval-2017, The Tel Aviv Coastal Forum workshops such as CAP Workshop 2019, IEEE Smart World NVIDIA AI City Challenge, The First Multilingual Surface Realisation Shared Task (SR'18), CAP Workshop 2019, Infoday Regional H2020 and many more, but also 43 publications giving an overall boost to science in this field. This large and through the years positive impact that was given for the beAWARE system from different fields of science helped the overall impact as also the dissemination strategy of the project.

Furthermore, beAWARE with its provided geolocation system not only allows for PSAP to view the exact location of the event but also inform first responders or citizens to head to a specific location with coordinates and of course citizens to give exact location with its coordinates of an event, without being at the spot, if their life is in danger. In all this effort MSIL integrated all the above data, creating the PSAP platform, supported by IBM's communication bus, cloud-based messaging service, based on standards and upon cooperation with the rest of the consortium.

Finally, cooperation between end users and technical partners throughout the whole process for the development of the system, allowed end users to support the development of an innovative solution through the fulfillment of their requests. Additionally, technical partners had direct access to the wills of the end users which offered them the ability to make scientific progress and support innovative solution based on actual needs of potential end user of the system

4.2 Economic impact

The economic impact of the project is not easy to measure, since it can be derived only indirectly from the outcomes and the benefits of the project and without properly set and test the beAWARE system for a well-accepted period of time. Nevertheless, various participants noted that beAWARE can be a very useful and supporting tool that can coordinate multiple resources such as national and volunteer first responders, instantly and accompanied with the existing legacy tools (VHF/UHF radios) resulting to a better coordination and management of these resources. As a result, the effective management of all resources can reduce the economic impact of managing an extreme event. For instance, by having from the area of the event, analyzed data of each incident, PSAP can dispatch specific and dedicated units reducing the cost as also the time of each operation.

Leading from the above, the positive impact for the economy is that thanks to the beAWARE system, the time of the operation is reduced resulting in lower operational costs. To add more, by having full knowledge of the situation, and the available resources, more sophisticated and dedicated personnel can be dispatched to its incident, resulting in better management of the crisis and reducing the overall costs of the operations.

4.3 Safety impact

Safety impact is very important, from decision-makers to citizens. From governmental representatives and PSAP operators that will take the proper decision to dispatch specific first responders or national authority to answer the call, to citizens that are in danger. Safety played a vital role in the development of beAWARE. For that reason, data acquisition and analysis reached a high level in order to address the call with safety and minimize the danger of the citizens, with special alerts, as also of the first responders with analyzed data from the incident that are dispatched.

Finally, beAWARE system successfully answered the expected impact of citizens' protection and saving lives, targeting the needs of users, from different authorities such as national and local law enforcement, climate and weather services, volunteer organizations of civil protection mechanism as well as private operators. This combination of different end-users gives a significant added value to the beAWARE because it answers different approaches and needs from all end-users' perspectives from different countries of Europe.

4.4 Training impact

beAWARE system can help PSAP operators, decision-makers, first responders and citizens to use it and in training events in order to maximize their efficiency and be more effective in order to tackle more success incidents in real life. beAWARE has already set a well-established procedure having a detailed script based on specific Use Cases and User Requirements for each pilot, external participants and an evaluation methodology contacted after each pilot. This procedure that beAWARE consortium followed can be used as a guideline for future training exercises from organizations or authorities that want to use beAWARE system in order to carry out exercises to meet their needs and increase their operational capacity.

4.5 Societal impact

beAWARE project has a different impact on each target group in the society. This is easily understood because there are different needs and requirements of each target group. From the target groups mentioned in other WP8 deliverables, e.g. D8.1, the impact on PSAP operators, policymakers and government representatives is positively large. This can be proven from the evaluation results and from the fact that beAWARE enables them to be able to prepare, and interact directly with citizens and first responders before, during, and after an event enhancing the communication and flow of information between all parties involved.

On the part of first responders and citizens, the impact of beAWARE is also positive here. Those groups are directly connected with the PSAP through the application and exchange important data from the event. Moreover, they also inform at any time their position, their situation and any changes that may take place in the area. Citizens are given the opportunity to participate in the overall crisis management system, giving information about the phenomenon and the various risks they identify. In the following sub-chapters the view of the

target groups is cited that strongly support the positive impact of the beAWARE system at their group.

4.5.1 Governmental authorities / PSAP operators

Governmental Authorities that are responsible to operate PSAPs, such as police, fire brigade, or generally the civil protection mechanism of a country have certain requirements in order to operate a PSAP at their station. The most important thing for a PSAP is to be easy to use, to handle incoming information smoothly and to allow outgoing commands to be sent as quickly and easily as possible, as well as understandable to the sender and to the recipient. In addition, it is important to consider that the PSAP may need as few operators as possible and therefore equipment to operate and be flexible in its management.

To add more, the representatives from governmental authorities stated that “beAWARE is a very interesting tool and will help in managing situation, as a support system”, “it can be a useful tool for us”, “has many potentials”, “it has a good and constant flow of data”, “platform map has good interaction time”. Those expressed opinions of the players showing that generally, beAWARE system, can be a supportive tool next to their already established decisional system.

Thanks to the continuous feedback to the technical partners from the end-users and the pilots’ participants, the final beAWARE platform that was created meet their needs and requirements. The main PSAP screens, which are the task manager screen and the main event map screen, offers the opportunity to the operators to have a clear view of the entire area of the event, different map layers and information that are required and to have the ability to assign tasks to the field rescue teams and inform citizens for an imminent danger. As a result, authorities can manage risks more productively and take appropriate decision affecting first responders and citizens in order to reduce their exposure to danger.

4.5.2 Policy Makers

Policy Makers and Governmental Representatives in general, who are involved in crisis management as well as in search and rescue operations are mostly interested to receive reliable and as comprehensible as possible information on time, in order to take action and make decisions as correct as possible. In addition, as it was extracted from the questionnaires and the discussions with the participants from the pilots, it was noted that governmental authorities need to be immediately informed of any change in the situation. This is very important, due to the fact that everything should be clearly presented on the platform, in order proper decisions and actions take place depending on the situation of the event. Finally, the processing of digital information coming to PSAP should be fast in order to properly evaluate the situation and if necessary, make appropriate adjustments again.

Additionally, the project's partners in order to promote the project to policy makers and strengthen its impact, made a lot of meetings with national authorities or entities to inform them about beAWARE project and its abilities.

As described in D8.3, various meetings with representatives of local, regional and national authorities (*see D8.3 table 2*), even from countries outside the project's consortium, took place in order to promote the beAWARE system and its potential to support the Crisis Management mechanism in each respective area.

In all those meetings, beAWARE system was presented in each different stage, to representatives from various entities and authorities. Politicians especially, recognized the need for tools like beAWARE risk management and all have recognized and confirmed the great impact of beAWARE system to Citizens and the Community. To add more, it was stated that since this system can be easily customized and integrated on existing systems, it can upgrade and enhance existing operations and services. In addition to the above meetings, consortium members made significant efforts to disseminate beAWARE project with well-established media coverage, such as publications in local newspapers, interviews in radio broadcasts as well as in their social media accounts resulting to positive interaction, visibility and impact for the project.

beAWARE platform, through the pilot exercises and online presentations after each pilot, has succeeded in proving that fast processing and analysis of digital information is possible. Data such as meteorological info, photos, videos, audio messages, texts from twitter are processed, analyzed and presented on the platform without long delays. This gives the ability to the policymakers to take decisions, faster, more accurate and in the correct directions as also to receive crucial information from the field, even from citizens.

Last but not least, as it was demonstrated in the final pilot of the project beAWARE system can be potentially used to connect a local or national emergency with the EU civil protection mechanism, potentially with an easy and direct way of communication. However, having that in mind, it is too early to estimate the potential impact on EU policies from the use of such a system and if in the future such a feature will be adopted. Nevertheless, the system can be adapted with little efforts to new crisis scenarios (such as heavy storms, snowstorms, etc.) beyond those covered in beAWARE offering an adaptable solution to policy makers that can used in different crisis regardless the scenario.

4.5.3 **First Responders**

First Responders from public authorities or voluntary organizations, which are mainly involved in SAR missions in the field, act as the intermediary between the PSAP and citizens in need. The primary concern of first responders is to get the right and necessary information from the PSAP as soon as possible in order to know the exact location of the area of the event, what's the event about, and in general acquire as much information as possible. In addition, interactive communication with the PSAP and the ability to send information quickly and immediately is a very critical and crucial need for first reposnders. Additionally, one of the

biggest problems in rescue operations is the difficulty of the continuous online communication because of the "blind" spots from which rescuers cannot send or receive data with new information about the event, due to lack of mobile coverage.

beAWARE platform and mobile application that have been tested in all three pilots, have proven to be able to send and receive a large amount of data from the PSAP to the field rescue teams and vice versa. As a result, the system can support exchange of information among first responders efficiently.

To support that, some statements that first responders made during the evaluation of the pilots were:

- *"beAWARE app could be a great support to the radio but not a total replacement",*
- *"detailed information and time saving",*
- *"useful supporting tool with high quality of data",*
- *"a good assisting tool"*

Those positives feedbacks from the first responders signify that beAWARE can assist them before and during an operation in order to maximize their efficiency.

Additionally, in all three pilots, the participants noted down that the mobile application menu is easily understandable, all the actions that should be taken can be achieved without problems and the data upload procedure was very familiar for them. Moreover, it is easily handled and offers only the required information without any unnecessary or irrelevant information that may cause unwilling concerns and queries. Finally, the majority of the first responders reported that the beAWARE mobile application can easily work seamlessly with existing technologies such as VHF/UHF communication, whereas the beAWARE mobile application was overall a good one and the overall reactions and use of it was in a satisfactory level.

It can be easily understood that the impact of a system such as beAWARE, to First Responders can be significantly high, especially taking into account the fact that the system can be used both as a stand-alone system and complimentary to legacy tools. It can support operation management in a productive way, which allows First Responders to be more efficient of the field.

However, it is worth mentioning that national services such as fire brigade, civil protection and police authorities besides their positive opinion for the system, state that in order to integrate such a system in their own mechanism, a political decision is required. Therefore, the impact on policy makers and authorities is crucial to the adaptation of the system by first responders.

4.5.4 General Public (Citizens)

In a state of emergency, the main concern of citizens is to be able to transfer the information as quickly and easily as possible to emergency services that they or other people are in danger. In addition, they want to transfer as much information as possible regarding their location, and if a photo, video or audio can be sent so as to make rescuers' work easier.

Through the continuous communication of technical partners with end-users to create a user-friendly and easy understandable mobile application, as well as the continuous improvements and changes that took place after each pilot thanks to feedback from pilots participants, the final version of the application that was created fulfill all the requirements of the participants based on the existing technology. Thanks to the beAWARE mobile application citizens can easily be informed of dangerous events and the affective area.

Additionally, the ability to attach files such as photos, videos or voicemails to send information to PSAP and rescue teams about and an emergency is easy and understandable based on the participants' opinion after the pilots. Last but not least, is worth mentioning that participants with the role of the citizen stated that beAWARE mobile application makes them part of the participative process of emergency management, as they contribute with their information, such as a photo, video or a voice message of the area of the event, while today they are almost totally outside of this process.

To add more, societal impacts were also noted and documented in all three pilots by the participants, especially citizens. As previously mentioned, when citizens participate in all the crisis management systems, especially when they send the important data (photos, videos or voice-calls) to the PSAP, feel that they too are involved in solving the problem and are a very important link in the rescue chain. Additionally, citizens when they know that PSAP and first responders have a combined coordinated system that will be used to support them, feel safer and more secure because operations will be organized and methodologically prepared and executed. Moreover, social media analysis by beAWARE adds and promotes another way of communication between citizens and authorities. Knowing that relevant posts are spotted by authorities it is safe to assume that citizens might increase the use of social media during an emergency, in order to support the crisis management mechanism as well as to provide information to the authorities even at a very early stage of the event.

Moreover, adding another form of communication which offers modern tools such as photo/video or voice-messages exchange between citizens and PSAP, gives the opportunity to crisis management operators to have useful analyzed data from the area of the event that can be proven important for the operation.

5 Contacts and Information

For further information visit the project web site **https://beaware-project.eu/** or send e-mail to the Project Coordinator Dr. Ioannis Kompatsiaris, **ikom@iti.gr**, to the deputy Project Coordinator Dr. Stefanos Vrochidis, **stefanos@iti.gr** or to the second deputy Project Coordinator & Scientific Manager Dr. Anastasios Karakostas, **akarakos@iti.gr**. You are also welcome to join us in social media:

Facebook: **https://www.facebook.com/BeAWARE.H2020/**

Twitter: **https://twitter.com/beAWARE_H2020**

YouTube: **https://www.youtube.com/channel/UCoogTOO-dmd4JSS47gC1nGw**

LinkedIn: **https://www.linkedin.com/groups/13515863/**

6 Journal and Conference Publications

All publications of beAWARE members are listed in the table below.

Table 4. List of publications

No.	Title	Authors	Publication	Type	DOI
1	FORGe at SemEval-2017 Task 9: Deep sentence generation based on a sequence of graph transducers.	Mille, S., Carlini, R., Burga, A., & Wanner, L.	Proceedings of the 11th International Workshop on Semantic Evaluation (SemEval-2017) (pp. 920-923), 2017	Conference	https://doi.org/10.18653/v1/s17-2158
2	Intelligent traffic city management from surveillance systems (CERTH-ITI)	Avgerinakis, K., Giannakeris, P., Briassouli, A., Karakostas, A., Vrochidis, S., & Kompatsiaris, I.	NVIDIA AI City Challenge 2017, 2017	Conference	
3	Visual and textual analysis of social media and satellite images for flood detection@ multimedia satellite task MediaEval 2017.	Avgerinakis, K., Moumtzidou, A., Andreadis, S., Michail, E., Gialampoukidis, I., Vrochidis, S., & Kompatsiaris, I.	Proceedings of the MediaEval. Workshop, Dublin Google Scholar, 2017	Conference	
4	A Demo of FORGe: the Pompeu Fabra open rule-based generator.	Mille, S., & Wanner, L.	Proceedings of the 10th International Natural Language Generation Conference (INLG); 2017 Sept 3-4; Santiago de Compostela, Spain. Stroudsburg PA: ACL; 2017. p. 245-6. ACL(Association for Computational Linguistics), 2017	Conference	https://doi.org/10.18653/v1/w17-3539
5	FORGe at WebNLG 2017	Mille, S., & Dasiopoulou, S.	Proceedings of WebNLG 2017	Conference	
6	FORGe at E2E 2017	Mille, S., S. Dasiopoulou	Technical Report Proceedings of E2E	Shared Task	
7	UPF at EPE 2017: transduction-based deep analysis.	Mille, S., Latorre, I., & Wanner, L.	Proceedings of the 2017 Shared Task on Extrinsic Parser Evaluation (EPE 2017); 2017 Sept 20; Pisa, Italy. p. 80-8, 2017	Conference	
8	LBP-flow and hybrid encoding for real-time water and fire classification.	Avgerinakis, K., Giannakeris, P., Briassouli, A., Karakostas, A.,	MSF 2017 IEEE ISPRS 4th Joint Workshop on Multi-Sensor Fusion for Dynamic Scene Understanding, in	Conference	https://doi.org/10.1109/iccvw.2017.56

No.	Title	Authors	Publication	Type	DOI
		Vrochidis, S., & Kompatsiaris, I.	conjunction with ICCV 2017, 2017		
9	A topic detection and visualisation system on social media posts.	Andreadis, S., Gialampoukidis, I., Vrochidis, S., & Kompatsiaris, I.	International Conference on Internet Science (pp. 421-427). Springer, Cham, 2017	Conference	https://doi.org/10.1007/978-3-319-70284-1_33
10	Flood Relevance Estimation from Visual and Textual Content in Social Media Streams.	Moumtzidou, A., Andreadis, S., Gialampoukidis, I., Karakostas, A., Vrochidis, S., &Kompatsiaris, I.	Companion of the The Web Conference 2018 on The Web Conference 2018 (pp. 1621-1627). International World Wide Web Conferences Steering Committee, 2018	Conference	https://doi.org/10.1145/3184558.3191620
11	The sensor to decision chain in crisis management.	Moßgraber, J., Hilbring, D., van der Schaaf, H., Hertweck, P., Kontopoulos, E., Mitzias, P., … &Kompatsiaris, I.	15th Information Systems for Crisis Response and Management Conference - ISCRAM 2018, Rochester NY, USA	Conference	https://doi.org/10.5281/zenodo.1243527
12	Intelligent Utilization of Dashboards in Emergency Management	Mordecai Y., Kantsepolsky B	15th Information Systems for Crisis Response and Management Conference - ISCRAM 2018, Rochester NY, USA	Conference	
13	“beAWARE: Enhancing Decision Support and Management Services in Extreme Weather Climate Events (Poster)”	Karakostas, Anastasios; Vrochidis, Stefanos; Kompatsiaris, Yiannis; Kantsepolsky, Boris; Moßgraber, Jürgen; Dasiopoulou, Stamatia; Mandler, Benjamin; Karppinen, Ari; Ferri, Michele; Vourvachis, Iosif; Castro, Carmen; Lintrup, Kim	15th Information Systems for Crisis Response and Management Conference - ISCRAM 2018, Rochester NY, USA	Conference, Poster Session	
14	Speed estimation and abnormality detection from surveillance cameras.	Giannakeris, P., Kaltsa, V., Avgerinakis, K., Briassouli, A., Vrochidis, S., & Kompatsiaris, I.	CVPR Workshop (CVPRW) on the AI City Challenge, 2018	Workshop	https://doi.org/10.1109/cvprw.2018.00020

No.	Title	Authors	Publication	Type	DOI
15	Ontology-based Representation of Crisis Management Procedures for Climate Events	Kontopoulos, E., Mitzias, P., Moßgraber, J., Hertweck, P., van der Schaaf, H., Hilbring, D., Lombardo F., Norbiato D., Ferri M., Karakostas A., Vrochidis, S. & Kompatsiaris I.	ICMT Workshop – Proceedings of ISCRAM 2018, 20.-24. Mai 2018, Rochester NY USA	Conference	https://doi.org/10.5281/zenodo.1243535
16	People and vehicles in danger-A fire and flood detection system in social media.	Giannakeris, P., Avgerinakis, K., Karakostas, A., Vrochidis, S., & Kompatsiaris, I.	IEEE IVMSP 2018, Image, Video, and Multidimensional Signal Processing, 2018	Conference	https://doi.org/10.1109/ivmspw.2018.8448732
17	Dynamic texture recognition and localization in machine vision for outdoor environments.	Kaltsa, V., Avgerinakis, K., Briassouli, A., Kompatsiaris, I., &Strintzis, M. G	Computers in Industry, 98, 1-13, 2018	Journal	https://doi.org/10.1016/j.compind.2018.02.007
18	Harmonizing Data Collection in an Ontology for a Risk Management Platform	Hilbring, D., Moßgraber, J., Hertweck, P., Hellmund, T., van der Schaaf, H., Karakostas, A., Kontopoulos, E., Vrochidis, S., Kompatisaris, I., Gialampoukidis, I., Andreadis, S.	EnviroInfo 2018, Garching, Germany	Conference	
19	beAWARE: Enhancing Decision Support and Management Services in Extreme Weather Climate Events	Anastasios Karakostas, Stefanos Vrochidis, Yiannis Kompatsiaris, Boris Kantsepolsky, Jürgen Moßgraber, Stamatia Dasiopoulou, Benjamin Mandler, Ari Karppinen, Michele Ferri, Iosif Vourvachis, Carmen Castro, Kim Lintrup, (2018)	EnviroInfo 2018, Garching, Germany	Conference	
20	A multimodal approach in estimating road passability through a flooded area	Moumtzidou, A., Giannakeris, P., Andreadis, S., Mavropoulos, A.,	MediaEval'18, 29-31 October 2018, Sophia Antipolis, France	Conference	https://doi.org/10.5281/zenodo.2540398

No.	Title	Authors	Publication	Type	DOI
	using social media and satellite images.	Meditskos, G., Gialampoukidis, I., …&Kompatsiaris, I.			
21	ITI-CERTH participation in TRECVID 2018	Avgerinakis K., Moumtzidou A., Galanopoulos D., Orfanidis G., Andreadis S., Markatopoulou F., Batziou E., Ioannidis K., Vrochidis S., Mezaris V., Kompatsiaris I.	TRECVID 2018	Conference	
22	Applying Semantic Web Technologies for Decision Support in Climate-Related Crisis Management	Kontopoulos, E., Mitzias P., Dasiopoulou, S., Moßgraber, J., Mille, S., Hertweck, P., Hellmund, T., Karakostas, A., Vrochidis, S., Wanner, L., &Kompatsiaris, I.	2nd International Conference Citizen Observatories for natural hazards and Water Management (COWM 2018), Venice, 27-30 November 2018	Conference	10.5281/zenodo.1297470.
23	A Crisis Classification System for flood risk assessment: the beAWARE project	G. S. Antzoulatos, A. Karakostas, S. Vrochidis, F. Lombardo, D. Norbiato, M. Ferri, I. Kompatsiaris	2nd International Conference Citizen Observatories for natural hazards and Water Management (COWM 2018), Venice, 27-30 November 2018	Conference	
24	Social Media Observations for Flood Event Monitoring in Italy over a One-Year Period	S. Andreadis, I. Gialampoukidis, R. Fiorin, F. Lombardo, D. Norbiato, A. Karakostas, M. Ferri, S. Vrochidis and I. Kompatsiaris	2nd International Conference Citizen Observatories for natural hazards and Water Management (COWM 2018), Venice, 27-30 November 2018	Conference	10.5281/zenodo.2545381
25	Using crowd source information for managing climate events through the use of modern mobile technology	Philipp Hertweck, Tobias Hellmund, Desirée Hilbring, Hylke van der Schaaf, Jürgen Moßgraber	2nd International Conference Citizen Observatories for natural hazards and Water Management (COWM 2018), Venice, 27-30 November 2019	Conference	
26	DRONES – Rescue from above	Guy-Ifergan N., Ben-Harrush I., Pikus D & Barnea M	2nd International Conference Citizen Observatories for natural hazards and	Conference	

No.	Title	Authors	Publication	Type	DOI
			Water Management (COWM 2018), Venice, 27-30 November 2018		
27	The Crisis Classification component to strengthen the early warning, risk assessment and decision support in extreme climate events	Gerasimos Antzoulatos, Anastatios Karakostas, Stefanos Vrochidis, Ioannis Kompatsiaris	Submitted to European Climate Change Adaptation conference – ECCA, 2019, Lisbon, 28–31 May	Conference	
28	DRONES TO THE RESCUE – Bringing muscle to weather Crisis Management	Benny Mandler	Web	Blog post	
29	The First Multilingual Surface Realisation Shared Task (SR'18): Overview and Evaluation Results	Mille, S., A. Belz, B. Bohnet, Y. Graham, E. Pitler, L. Wanner	Proceedings of the 1st Workshop on Multilingual Surface Realisation (MSR), 56th Annual Meeting of the Association for Computational Linguistics (ACL)	Shared Task	https://doi.org/10.18653/v1/w18-3601
30	Underspecified Universal Dependency Structures as Inputs for Multilingual Surface Realisation	Mille, S., A. Belz, B. Bohnet, L. Wanner	Proceedings of the 11th International Conference on Natural Language Generation	Conference	https://doi.org/10.18653/v1/w18-6527
31	Sentence Packaging in Text Generation from Semantic Graphs as a Community Detection Problem	Shvets, A., S. Mille, L. Wanner	Proceedings of the 11th International Conference on Natural Language Generation	Conference	10.18653/v1/W18-6542
32	beAWARE: innovative approach in the support and integrate management of extreme weather events (in Italian: "beAWARE: approccio innovativo per il supporto decisionale e la gestione integrata di eventi climatici estremi")	Ferri M., Norbiato D., Tomei G., Lombardo F., Zaffanella F.	Book of Abstract of the Days of Hydrology 2018 (Giornate dell' Idrologia 2018); 2018 June 18-20, Rome, Italy. P. 80-81 (In Italian), 2018.	Conference	
33	Providing meteorological data for emergency response in the beAware project	Karppinen A.1, Tyuryakov S.1, Wood C.1, Rantamäki M.1, Tarvainen V.1, Ylinen K.1, Lombardo F.2, Monego M.2, Ferri M.2 & Norbiato D.2 1 Finnish Meteorological	Abstracts of the 2nd International Conference on Citizen Observatories for Natural Hazards and Water Management. Venice, 27-30 November 2018	Conference abstract	

No.	Title	Authors	Publication	Type	DOI
		Institute 2 AAWA			
34	A portable grammar-based NLG system for verbalization of structured data.	S. Mille, S. Dasiopoulou, L. Wanner	34th ACM/SIGAPP Symposium on Applied Computing (SAC'19)	Conference	https://doi.org/10.1145/3297280.3297571
35	Management of Sensor Data with Open Standards	P. Hertweck, T. Hellmund, H. van der Schaaf, J. Moßgraber, J. Blume	ISCRAM 2019	Conference	
36	A Filtering and Visualization Workbench for Messages in Crisis Management	J. Blume, P. Hertweck, T. Hellmund, J. Moßgraber	ISCRAM 2019	Poster presented on Conference	
37	Towards to integrate a multi-layer Machine Learning Data Fusion approach into Crisis Classification and Risk Assessment of extreme natural event	Gerasimos Antzoulatos, Anastatios Karakostas, Stefanos Vrochidis, Ioannis Kompatsiaris	MSE2019 – Mediterranean Security Event 2019, October 29th – 31st, 2019, Heraklion, Crete, Greece	Conference	
38	"Multimedia Analysis Techniques for Flood Detection Using Images, Articles and 39Satellite Imagery"	S. Andreadis, M. Bakratsas, P. Giannakeris, A. Moumtzidou, I. Gialampoukidis, S. Vrochidis, I. Kompatsiaris,	in Proceedings of the MediaEval Workshop, 27-29 October 2019, Sophia Antipolis, France	Workshop	
39	The backbone of decision support systems: the sensor to decision chain	Philipp Hertweck, Jürgen Moßgraber, Efstratios Kontopoulos, Panagiotis Mitzias, Tobias Hellmund, Anastasios Karakostas, Désirée Hilbring, Hylke van der Schaaf, Stefanos Vrochidis, Jan-Wilhem Blume, Ioannis Kompatsiaris	International Journal of Information Systems for Crisis Response and Management (IJISCRAM)	Journal	10.4018/IJISCRAM.2018100104
40	Semantic Queries supporting Crisis Management Systems	Manfred Schenk, Tobias Hellmund, Philipp Hertweck and Jürgen Moßgraber	The Thirteenth International Conference on Advances in Semantic Processing SEMAPRO 2019	Conference	

No.	Title	Authors	Publication	Type	DOI
41	Employing Geospatial Semantics and Semantic Web Technologies in Natural Disaster Management	Tobias Hellmund, Manfred Schenk, Philipp Hertweck, and Jürgen Moßgraber	Semantics 2019, September 2019, Karlsruhe	Conference Poster	
42	The Second Multilingual Surface Realisation Shared Task (SR'19): Overview and Evaluation Results	Mille, S., A. Belz, B. Bohnet, Y. Graham, E. Pitler, L. Wanner	Proceedings of the 2nd Workshop on Multilingual Surface Realisation (MSR), International Conference on Empirical Methods in Natural Language Processing, October 2019	Shared Task	https://doi.org/10.18653/v1/d19-6301
43	Teaching FORGe to Verbalize DBpedia Properties in Spanish	S. Mille, B. Fisas, S. Dasiopoulou, and L. Wanner	12th International Conference on Natural Language Generation. Tokyo, Japan, 2019	Conference	https://doi.org/10.18653/v1/w19-8659